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The Industrial Archaeology of The Portsmouth Region

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Cover:
A cannon bollard at the Camber Dock, Portsmouth
R. C. Riley

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THE INDUSTRIAL ARCHAEOLOGY OF THE PORTSMOUTH REGION

R. C. Riley, BSc(Econ), PhD

Introduction

The realisation that the process of change usually involves the destruction of artefacts not infrequently of considerable importance in former times, coupled with the existence in Britain, the first industrial nation, of a great many innovatory developments, has engendered a general interest in the physical remains of the industrial past. This application of a particular aspect of our environmental heritage has come to be termed industrial archaeology. Some writers argue that the subject should be essentially concerned with the industrial revolution,[1] others such as Raistrick[2] accept that an arbitrary historic start point is unjustified, but see the complexities of twentieth century industrial society as too onerous a field of study for everyone but the specialised expert, while a growing majority following the pioneering work of Rix and Hudson[3] urge that the recent past is of equal importance, given the exponential rate of technological progress. As relevant as any is Buchanan's definition: 'a field of study concerned with investigating, surveying, recording and, in some cases, with preserving industrial monuments'.[4]

If the time scale is not a problematic issue, the same cannot be said for the ramifications of the term 'industrial'. There is however a powerful case for equating industry with agriculture and manufacturing, together with the means of transport including street furniture, and supporting public utilities such as water, gas, drainage and electricity supply. By implication services such as retailing, offices and entertainment are excluded, as indeed is workers' housing. This definition does not command the support of all industrial archaeologists – a more discursive approach is adopted for instance by Mrs Moore in her guide to Hampshire and the Isle of Wight[5] – but its precise dimension does prevent the subject from becoming excessively broad. Whatever definition is employed, commentators on the industrial archaeology of regions invariably take up a sectoral stance, treating each industry separately. In order to place artefacts within their historic context, the approach taken in this paper is chronological rather than sectoral. Where structures have been modified, for the sake of cohesion they are considered within the period of their origin. The Portsmouth region is regarded as including the neighbouring towns of Gosport, Fareham, Havant and Emsworth, in addition to the city itself. Six figure map references are provided for sites outside Portsmouth Dockyard.

The Eighteenth Century and Earlier

Defence Supply

It is widely thought that Portsmouth owes its origins to the decision by Richard I in 1194 to establish a base on the south coast of England from which he could mount an attack on France. The town's subsequent growth was largely linked to monarchical and governmental views of its strategic value. Thus following the Glorious Revolution of 1688 and the accession of William III, France became the military target once more in place of the Dutch, causing funds to be diverted from Deptford, Woolwich and Chatham to Portsmouth and Plymouth. A major dock building programme was inaugurated in 1689 and completed in 1698; some of the work remains, endowing Portsmouth with the relics of an early and particularly innovatory dock system.[6]

The Surveyor to the Navy Board, Edward Dummer, was given charge of the project and he determined to improve the efficiency of existing dry dock designs. Traditional dry docks were made of wood having almost vertical walls, and while inexpensive to construct, they leaked water, were relatively unstable and were inconvenient places in which to work. Dummer's Great Stone Dock, now No. 5, was given stone stepped sides with a broad walkway or altar at mid-height, which at once assisted its watertightness, strength and the ease with which repairs could be undertaken. In addition a series of slides was incorporated to facilitate the movement of heavy materials to and from the underside of the hull. It was the first stone dock in the country.[7] The need to increase the capacity of the Great Basin, which Dummer had built between the Harbour and the Great Stone Dock, recognised during the Seven Years' War by the plan of 1761,[8] caused the Great Stone Dock to be rebuilt in 1769 slightly to the east, the original dimensions being unchanged. Apart from the entrance, which has been modified in keeping with the thinking of Samuel Bentham, who was Inspector General of Naval Works from 1796 to 1813, and the head, restructured to accommodate the bows of iron-hulled vessels in 1906,[9] the present No. 5 Dock bears a very close resemblance to Dummer's epoch-making design. It is probable that the vertical rebates cut into the stonework above the broad altar, almost certainly to take the shores used to maintain vessels in the vertical position, were also Dummer's work. Dummer's scheme also provided for the construction of a large basin, access to which was achieved through a small wooden sided dock. Rebuilt in stone by 1743 and modified in 1777,[10] this structure, known formerly as North Dock and now as No. 6, has suffered scant rebuilding at its head because of the proximity of the Block Mills, and consequently is closest in scale to the original form of the early Georgian docks. Questioning the logic of the presence of a building slip issuing into the Great Basin, whose function was essentially that of repair, the instigators of the 1761 plan proposed its replacement by a further dry dock, completed in 1771.[11] No. 4 Dock, as

it now is, was selected for lengthening in 1858 following the changes triggered by steam propulsion, and a pontoon, or caisson, provided in place of the conventional gates. With its steep sides, length and caisson, No. 4 Dock offers a modern counterpoint to its predecessors.

If the docks were the site of ship repair, the supplies for this activity were brought in by the sea itself. The increase in deliveries first occasioned by the Seven Years' War gave rise between 1773 and 1785 to the construction of the 660 ft long Camber where supply ships could berth. To overcome problems in unloading created by the rise and fall of the tide, between 1801 and 1807 a caisson was introduced into the Camber, rendering part of it non-tidal, although this has been replaced by a bridge since the Camber no longer serves as a main transshipment point. To the south of the Camber a short section of canal with lock gates, still in situ beneath Main Road, was provided in 1797 to allow access to the Mast Pond without interfering with the level of sea water in which masts were stacked.[12]

Mindful of the fire risk inherent in wooden structures, the 1761 plan called for the construction of brick storehouses and workshops.[13] Hitherto the material employed had been timber, giving rise to buildings not unlike the present Nos. 5 and 7 Boathouses which adjoin the route to the *Victory*, characterised by wooden cladding, proud window frames and tiny panes, despite their completion dates of 1882 and 1875 respectively. The three warehouses at the Camber, Nos. 9, 10 and 11 Stores, opened in 1782, 1776 and 1763 respectively, are timber framed, austere yet elegant pedimented structures in the best Georgian tradition. Similar buildings were to be found in commercial ports, but with the growth of maritime trade their size became a limitation, and only in ports which did not witness expansion, such as Newport, Isle of Wight, did they remain. The Portsmouth group is thus an important survival. Evidence of the railway age is to be seen in the wall plates for cranes whose jibs reached to the track running behind the storehouses, and a 30 ton capacity weighbridge outside No. 9 Store.[14] To the east of No. 10 Store is a line of three hemp stores in more muted style, notably reinforced by buttressing, an unusual feature in Dockyard buildings. Nos. 15 and 16 were completed in 1771, No. 17 in 1782. The final pedimented storehouse, completed in 1788, in this cluster of outstanding industrial buildings is unusual in that it has but two storeys in place of the customary three, and matches an office block designed for this purpose in 1786. The two buildings now form part of the South Office Block.

Erected between 1786 and 1790 were four buildings intended to double as workshops and stores.[15] One was destroyed in the Second World War, but the others remain, albeit much altered. The South-East Building, No. 25 Store, is closest to the original form. It is almost square in plan, but has a courtyard down its centre, effectively creating two slim buildings, access to which is through fine wooden framed doors. A third storey has been added to the South-West Building, No. 24 Store, removing the arresting skyline embellishments of its neighbour. Not all aspects of shipbuilding and repair could be undertaken in non-specific accommodation, and three buildings which survive from this period were nothing if not specialised. Hemp for rope making was carded in the Hatchelling House of 1771, now No. 19 Store, and then conveyed to the 1,095ft long Great Ropehouse, No. 18 Store, opened in 1776, where spinning was executed on the upper floors and rope wound on the ground floor. The Hemp Tarring House, now Boiler Shop West, finished in 1770, completes this group. Structurally as important as these industrial buildings is the Pay Office which was in all probability the first example of fire-proofing in the Dockyard. It has cast iron compound columns[16] carrying brick vaulting in place of timber piers and beams, and is thought to date from 1798, possibly by Bentham.[17] Certainly the fire-proofing contributed to the survival of the ground floor, if not the first, during a Second World War air raid. The building is now host to the RN Cinema Corporation.

Gunpowder was a key provision taken on by men of war, but the obvious hazards associated with its storage in the Dockyard had caused the Square Tower in Old Portsmouth to be used for this purpose. The growing size of the fleet, coupled with a petition in 1768 from the burghers, who feared the accidental destruction of their town, prompted the Board of Ordnance, which was until 1855 responsible for ships' supplies, to establish a magazine and stores at Priddy's Hard,[18] Gosport (616012). Begun in 1773 and finished in 1777, it was the work of Major Archer RE who was also responsible for the contemporaneous Portsea fortifications, and indeed Priddy's Hard received its own bastion trace ramparts. It was the earliest instance in Britain of the separation of gunpowder from other ordnance stores,[19] which were concentrated at Weevil Lane to the south. Concomitant with its function, the magazine is of great strength, comprising 6ft thick double skin brick walls to which are added eight substantial buttresses, of which two are at the gable ends. Some narrow ventilation slits apart, the building lacked windows since these would have represented a serious weakness in the containment of an explosion. The interior consists of wooden flooring and pegging to reduce the risk of sparks, non-ferrous metal parts on doors for the same reason, and a series of low, powerful barrel vaults carrying a sand filled roof which gave protection against bomb attacks. It was the weight of this roof that contributed to the need for buttressed walls. Some 4,500 barrels each containing 100lbs of powder

could be stored, providing ample ammunition for Portsmouth's plea to discontinue harbouring such a lethal burden. Barrels were trundled in barrows down the rolling way, now walled in, to the small tidal basin from which the hoys, or lighters, supplied vessels in the Harbour. The basin is in good repair, which cannot be said of the one remaining of the two powder piers later constructed to ease the problem of loading hoys in the basin itself. Two other smaller and more conventional buildings, a cooperage and shifting house, both an integral part of Archer's original scheme, survive to make this the most complete example of its type remaining in England.[20] It has since 1971 appropriately housed the Royal Naval Ordnance Museum.[21]

Stores for weapons and shot had first been established at the Gunwharf by the Board of Ordnance in 1662, and the Napoleonic Wars prompted the construction of the New Gunwharf on made ground between 1797 and 1814; in combination the two later became HMS *Vernon*. The pedimented three storey Grand Storehouse or Vulcan Building (632998) of 1814 is the most impressive relic of this era.[22] Despite the removal of the north wing through bomb damage, the scale of the original is evident; the first floor is carried on cast iron columns, a relatively early instance of the practice. Also deriving from this period is a small two storeyed store more in keeping with the subdued style of Board of Ordnance buildings. It is thought that the older magazine at Tipner (638034), whose near elliptical form may be seen from the motorway, may have been constructed between 1810 and 1812, although it is now owned by a firm of scrap merchants and deterioration is rife.

A second equally vital component of ships' stores was sustenance for the crew. This was until 1832 the responsibility of the Victualling Board, which operated from a number of disparate properties in Old Portsmouth, including a bakery and storehouse in King Street and a slaughterhouse near Sally Port,[23] while in 1779 the Square Tower became a meat store. Beer was purchased from local brewers such as the Ridge family, and at Gosport, Henry Player. Largely because of fraud on a grand scale the Victualling Board bought Player's Weevil Brewery[24] (617005) in 1751, and following extensions in 1758, by 1761 production was such that they were able to dispense with supplies from contractors.[25] Subsequent enlargements between 1778 and 1780[26] included a sizeable cooperage set out in an irregular quadrangle, much of which has survived, despite the destruction of many other proximate buildings in the Second World War, and the discontinuation of the rum ration in 1970. The buildings which are now part of the Royal Clarence Yard, are single storey, wooden framed and clad, large windowed structures which housed not only barrel making, but also a seasoning house, both wood and iron stores, a condemned store and a small saw mill. These activities have now ceased and an air of desolation is strikingly evident.

Although the Victualling Board's experience indicated that a policy of self-sufficiency was advantageous, it was not always possible to implement such action and the Board was forced to accept contractors' prices. This was the case with iron supplies for items such as mast hoops and bracing for beams known as knees. It must have been with some delight that in the late 1770s the Board found a local supplier who was not only able to undercut prices habitually paid, but also to deliver wrought iron of exceptional quality. A quirk of family fortune had in 1775 brought Henry Cort, who had worked as a Navy agent in London, and who was thus familiar with contracting procedures, to Funtley (550082) near Fareham to take over a small iron works on the River Meon. He set to work to improve the site, enlarging the pond to provide more power for tilt hammers and rollers. More importantly, despite his lack of a metallurgical background, he begant to experiment with grooved rollers for the speedy and accurate shaping of hot metal, and took out a patent on his design in 1783. Not content with this important advance, the following year he patented a method of producing wrought iron, valuable because of its malleable quality, employing a reverbatory furnance. These were innovations of international significance and gave Cort a leading place in the annals of the industrial revolution. Ironically the enterprise flourished only briefly, not so much from the severe power limitations of the site, but rather from bankruptcy in 1789 following litigation involving his partner Jellicoe's father, a naval paymaster. The premises were burnt down in 1878, but the outline of the pond, a brick lined tunnel through an embanked road allowing water from the pond access to the wheel pit, a second adjacent tunnel through which water was conducted from a downstream spring in the valleyside to the pond, and several sluices and overflow channels from the feeder leat to the River Meon are all clearly visible. The wheel pit is intact, indicating that the undershot wheel was no more than 12ft 6in in diameter and 4ft wide, and there is evidence that the controlling sluice gate was inclined, although this innovation which served to increase the force of the water acting on the wheel, may have been introduced after Cort's period of ownership. In the north wall of the works, which remains since it shores up the access road to a farm, are the bricked up arch to a second, smaller wheel, and two recesses which may have contained securing points for tilt hammers. A clearly defined scoring mark locates the position of the pit wheel almost certainly used to drive the rollers. A careful but unpublished survey of the site by Peter Sin-

ger in the late 1970s has revealed the position of the furnace and the rollers. The walls of the coal store survived in excellent condition, largely because the building was used as a farm shed, while neighbouring walls and paths are liberally sprinkled with slag as ample evidence of the site's function. That such a minute enterprise could supply much of the Dockyard's wrought iron requirements is testimony to the nature of contemporary shipbuilding.[27] Cort also operated a furnace on the edge of the Gosport town green, perhaps to reduce the bulk of material to be dispatched by horse drawn transport to Funtley; it is highly unlikely that he could have operated rollers or tilt hammers at such a location devoid of water power.[28] Cort's contribution to metallurgy is recognised by a plaque at the Funtley site, [29] and in the low relief frieze above Gosport Borough Museum entrance.

If the Dockyard, its outposts and suppliers have monopolised the discussion, this merely reflects their importance in the local economy. By eighteenth century standards, the Royal Dockyards were vast undertakings. In January 1774 some 2,198 men were working inside, and 685 on naval ships outside Portsmouth Dockyard,[30] a complement which would even today be regarded as large. Perhaps because the Dockyard buildings were so substantial and proved capable of being adapted to other uses they have been retained, while almost all other urban industrial premises of the eighteenth century have disappeared. Certainly the most numerous remaining structures of the period outside the aegis of the Dockyard are in rural areas where competition for land was low and where food production and processing held sway.

Agriculture

Despite the possibility of Dockyard contracts for grain and meat, coupled with growing outlets in Portsmouth and to some extent other towns, not least of which was London, agriculture was carried on in traditional fashion, remnants of the feudal system merging with smaller and later activity. The sheer size of the barn at Manor Farm, Hayling Island (721008), suggests that it is a survival from the feudal, and possibly monastic period. It is aisled,[31] wooden clad, has eleven bays and is some 45 yards long; the timber framework indicates that there were originally two wagon doors with canopies on each side which would certainly have been justified for a barn of this length. In many ways an even more spectacular relic is the farm's dovecote, the later part of which dates from 1325.[32] It comprises two contiguous rectangular stone buildings from which the glovers[33] have been removed, but within which are approximately 600 nests lining the walls, an eloquent indication of the social standing of the lord of the manor. More muted is the barn at Newlands Farm on the Southwick Estate (665086) which not only possesses a mere six bays, but also is not aisled, giving it a markedly slender appearance. However the farm buildings are an almost classic example of the eighteenth century rectangular farmstead,[34] with stables, harness room, cattle shed, loose boxes and pigsty arranged about the yard. Set back from the entrance is the farmhouse, and nearby is a wooden clad staddle barn or granary. The buildings may not all derive from the same period, but it is reasonable to suppose that the layout is original. A further feudal barn is at Manor Farm, Warblington (728054) which has only five aisled bays, although it is larger than other elderly barns such as the two thatched, three-bay, aisled structures at South Hayling (722991) and West Town, Hayling Island (711995). Both the latter have assymetric roofs, but since their lower walls face east and west respectively, their design cannot be an attempt to minimise the effect of westerly winds. The half-timbered farmhouse at Green Farm, Hilsea (659037) is indicative of a long established enterprise, but the size of the bricks at the base of the seven bay, wooden clad barn suggests that it is a nineteenth century structure, as is the associated staddle barn. A relic of the era prior to the arrival of the railway when cattle were walked to market is a short length of drove road, which doubtless once led to Portsmouth, between the A333 (632079) and New Barns Farm (631075). At its junction with the main road it is 34 yards wide.

Food Processing

Following the importance of bread in the contemporary diet in an era before imports from the New World struck at the basis of British farming, it is not surprising that grain production and therefore flour milling were widespread activities. Natural sources of power were harnessed in continuation of the age old practice of producing flour by the action of a runner stone upon a bedstone. Some 16 windmills, 15 water mills and 10 tide mills are known to have worked in the study area,[35] the large number of windmills reflecting the local paucity of water power, and the importance of tide mills the abundance of sheltered tidal creeks. Visible remains survive of three windmills, ten water mills and four tide mills, and almost all were working by 1800. Largely because their sites have been overtaken by urban expansion – there were five between Mile End and Flathouse alone – windmills are relatively rare, and indeed the remains of Dock Mill, Southsea (650989), are restricted to workers' cottages, although the outline of the base has been incorporated into the court of municipal flats.[36] The truncated stone tower of the diminutive Portchester Mill (619044) is now used as a store, but more impressive at the water's edge is Langstone Mill (720049), its sailless, double-pitched tower painted black by its residents, and its

new roof giving it the appearance of a lighthouse. Conceivably flour from Portchester Mill could have been dispatched by water for it is effectively on the seashore, but there is no element of doubt about Langstone Mill's participation in this traffic, for the wooden wharf against which vessels tied up unequivocally remains. As though to convince sceptics, the hulk of a sailing barge lies slowly rotting a few yards offshore.

The rural locations of water mills have been responsible, at least in part, for the survival of two-thirds of those once in operation, even if their economic life ceased in the early years of this century as a consequence of new technologies, in particular roller-grinding which allowed substantial economies of scale, and imported grain.[37] The line of springs at the foot of the Downs between Bedhampton and Havant has given rise to a cluster containing more than half the survivors. Bedhampton Springs provided power for Upper Mill (704061), of which only a section of wall remains, and for Bedhampton Mill (703061), where the wheelpit, the races and sluices are extant. An indication of the size of these mills was the existence of railway sidings at both by 1869.[38] To the east, Brockhampton Stream was used at Brockhampton Mill (707057) from Domesday until 1870, when the mill and water supply were bought by the Portsmouth Water Co.; a residual pond and sluice gates are still to be seen, as are the remains of an adjacent tidal quay, supporting the hypothesis that the local plethora of mills was stimulated by the possibility of coastal exports, even if the destination of some was Portsmouth Harbour. Town Mill, Havant (715059), first recorded in 1460 as Place Hall Mill, drew its water from Homewell spring. It was rebuilt in 1822[39] with five storeys, a classic double mansard roof and an undershot wheel, of which the pit, canted sluice frames on the Smeaton principle,[40] and overflow channels still exist. The site is particularly interesting since it incorporates brickwork channels for the flow of water to and from adjacent water meadows. In the normal way millers were reluctant to share water in this manner, and doubtless the arrangement stemmed from the vagaries of land ownership. On the same stream lies West Mill, Langstone (714050), which worked until 1914, having the advantage of a tidal quay; all that remains is the wheelpit and a small, neat bridge over the tidal race. Langstone Mill, on the same site as the windmill referred to above, but using water from Lymbourn Spring, is a tiny two storey structure, but it possessed a sunken wheelpit allowing the water to meet the wheel at breast height, thereby using gravity rather than the less efficient force of water to ensure rotation. This strategy was proposed by Smeaton, and its use here suggests the presence of a dynamic miller, although the juxtaposition of water and windmill itself supports this view. Because the southern edge of the mill pond is also the sea wall, it has been preserved in good condition, and with it the millpond itself. Indeed, water still flows over a concrete sill into the mill before debouching through a culvert into the sea; no equipment remains within the mill. The seaward side of the millpond is breached by a sluice gate to allow the escape of excess water. It has been suggested that this gate permitted the ingress of sea water to the pond, but since even spring tides would have provided insufficient height of water to turn the wheel, this is not a tenable theory.

Of the other water mills, the most impressive in the context of existing artefacts is Boarhunt Mill (606091), on the River Wallington. Architecturally it is less striking than the fine Georgian mill house, but with the exception of one stone nut it contains a full set of drive machinery, including two pairs of Derbyshire stones, and, above, a crown wheel from which a layshaft drove the sack hoist and grain sifting equipment. Outside lies the metal framework of an overshot water wheel together with a wooden pentrough or conduit which controlled the volume of water falling on the wheel.[41] The machinery that remains is illustrated in Figure 1. Smeaton's experiments had revealed that overshot wheels were almost three times more efficient than the undershot variety. However in flat terrain difficulties often derived from the need to secure a sufficiently high mill race, combined with the necessity for the tail race to drain away naturally. In this instance the problem was overcome by tapping the Wallington some distance to the east and constructing a linear mill pond. The latter is now entirely dry. Two mills derived their water from the River Ems. Lumley Mill (752064) was itself burnt out in 1915, but the metal launder and pentrough which gave upon an overshot wheel, the metal spokes and pitwheel of which remain, constitute the most modern conventional water wheel relics in the area, dating from the latter part of the nineteenth century.[42] That this was a profitable enterprise is not in doubt for the mill house is not only a baroque extravaganza but also a very substantial dwelling house built by the owner Edward Tollervey, who prospered from Dockyard contracts in the 1850s. Below it on the river is the four storey Town Mill, Emsworth (751058), completely rebuilt in 1897, but the site if not the existing remains, belong to the eighteenth century. The reconstruction incorporated an Armfield turbine, the most efficient method of extracting energy from flowing water,[43] driving rollers and two pairs of 48in conventional stones.[44] The turbine mechanism is still in place beneath the ground floor, and the building which has been converted to a flatted factory is notable for its use of elegant iron framed windows. The stream on which Southfield Mill, Fareham (579057) was sited appears to have been insignificant, and this may have been an important consideration in its re-

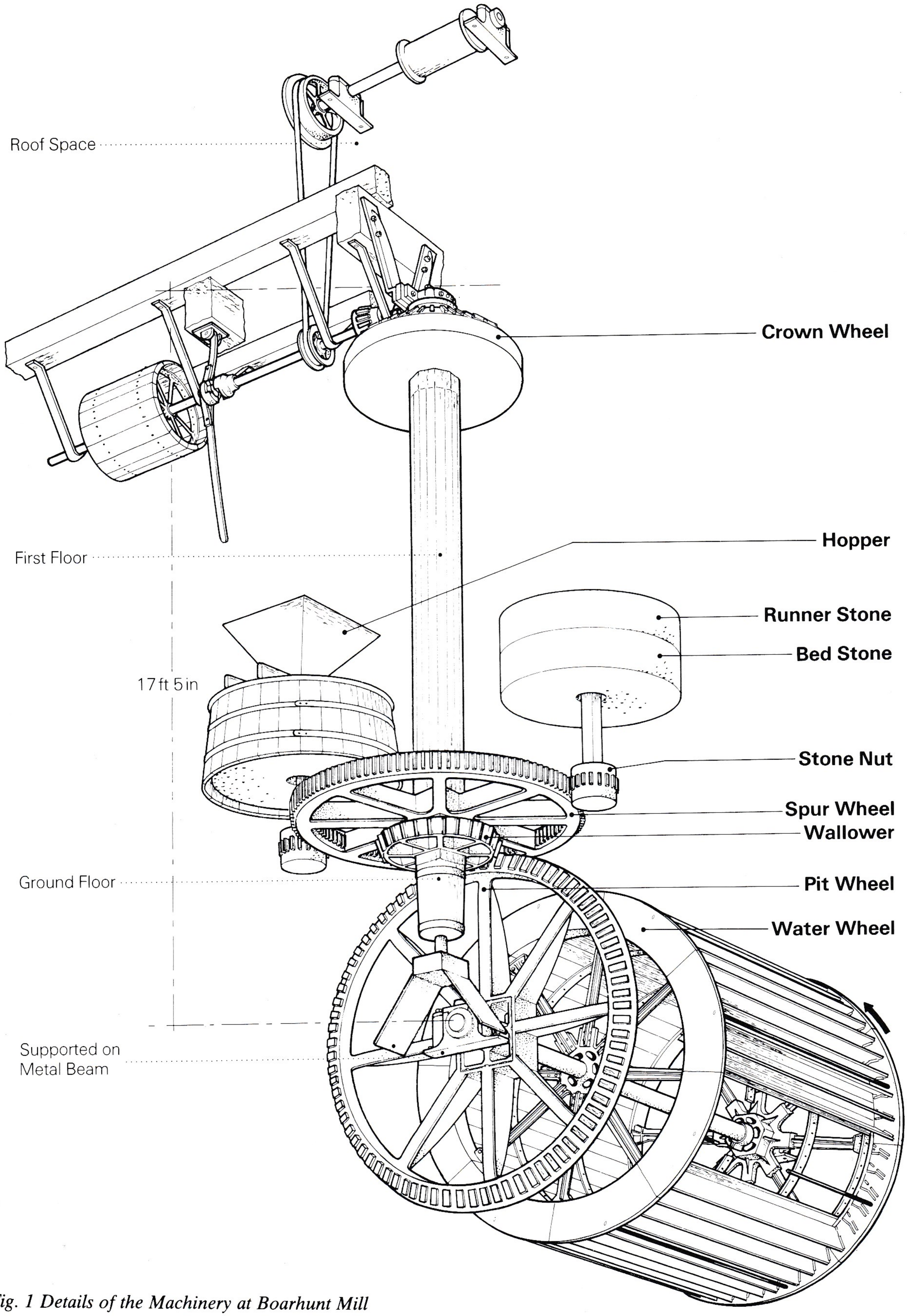
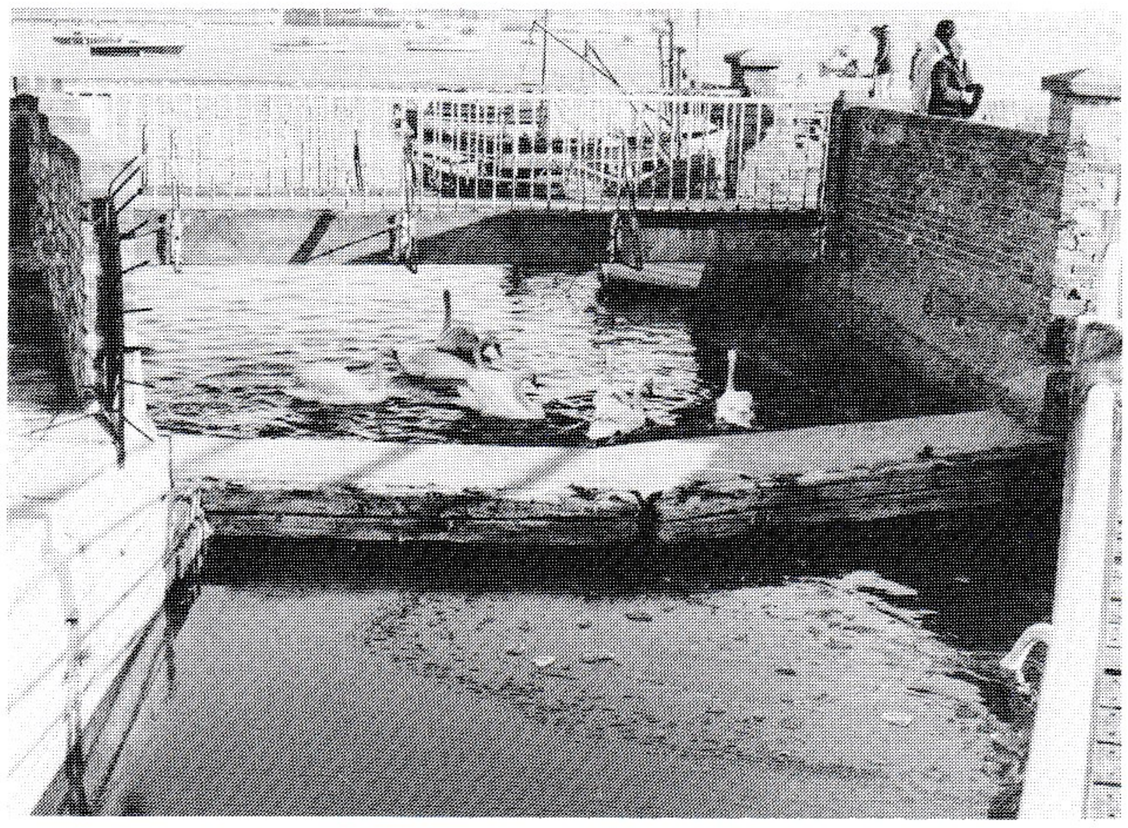


Fig. 1 Details of the Machinery at Boarhunt Mill

Quay Mill, Emsworth
R. C. Riley



The tide pond gates at Quay Mill, Emsworth
R. C. Riley

construction in 1830 when it became a substantial four storey, flat roofed, steam-driven mill, and all evidence of the earlier structure removed. The flooring is supported by cruciform-plan iron columns whose diameter diminishes from the ground floor upwards.[45] Outside the Royal Clarence Yard it is the only purpose-built steam mill in the region[46] and doubtless the early date for this kind of motive power was also influenced by good access to coal brought up Fareham Creek.

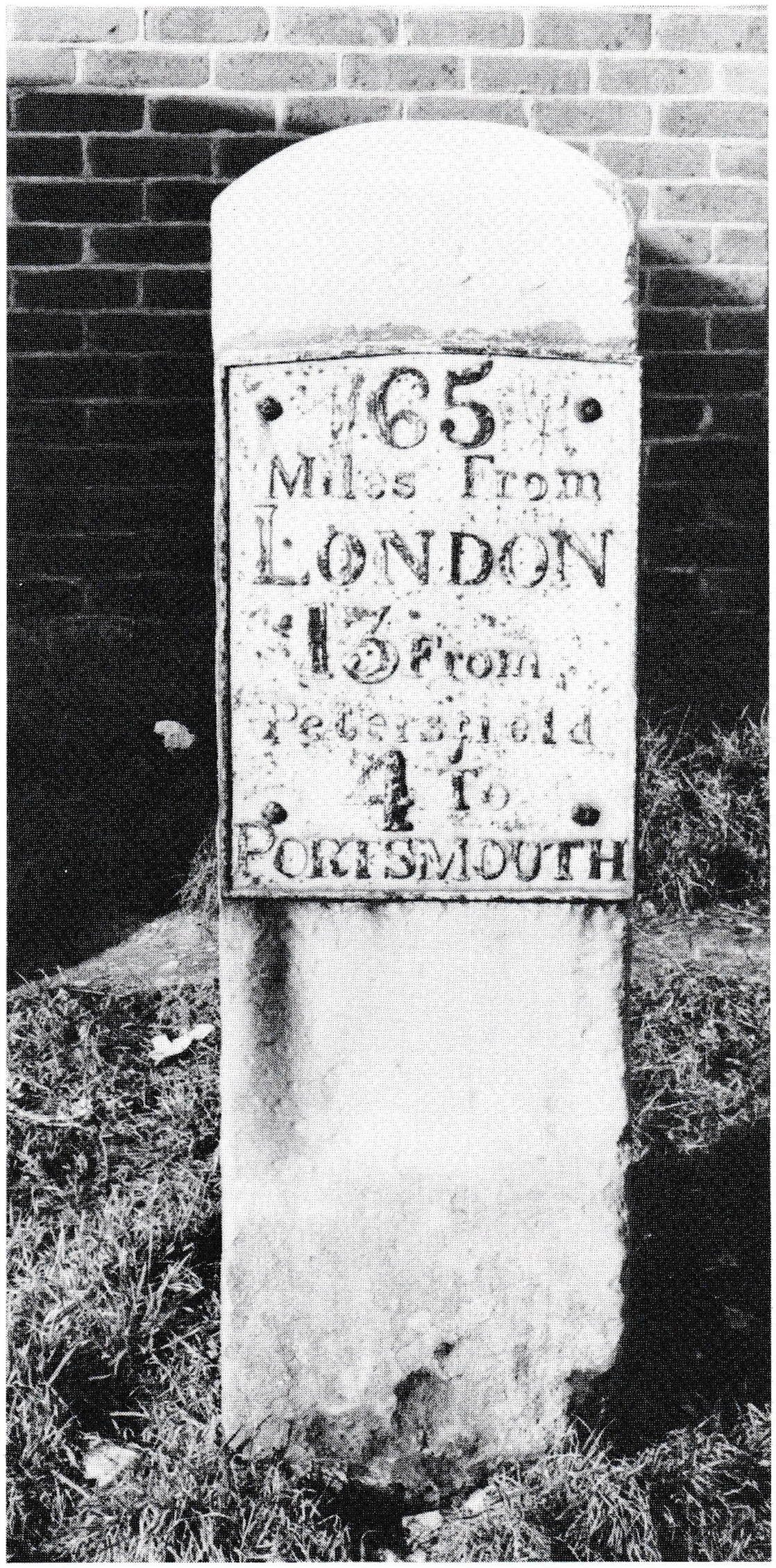
Because the ponds employed to trap sea water for use in tide mills had to be large, and because by definition they were maritime, they have often been translated to marinas or retained on environmental grounds, while their mills have sometimes been demolished. Fortunately Quay Mill, Emsworth (748055), has been preserved, in modified form, as a sailing club. The land was conveyed in 1759[47] and the flood gates constructed of sufficient width to permit the entry of small vessels to the pond. The gates have been replaced by concrete walling, but the tide still fills the pond through the provision of slots in the concrete covered by wooden, hinged flaps, against which the ponded water presses as the tide ebbs. Despite the volume of water contained in the 10 acre pond, tidal power was dispensed with when a steam engine was installed in 1884,[48] a gas engine being substituted in 1921; until recently the cooling tanks and drive belt channels from the engine house were clearly visible. The mill is in two sections, the west building – a storehouse – being half-timbered standing on brick piling in the pond itself. The outflow from the second, larger building which housed the undershot wheel driving four pairs of stones, remains. Acting as a doorstep on the north side of the mill is a French burrstone of the type imported in large numbers from quarries at La Ferté sous Jouarre (Seine-et-Marne) in the nineteenth century.[49] The original structure of Slipper Mill, Emsworth (754054), rebuilt in 1735,[50] has, in spite of its closure as recently as 1945, disappeared, save for that part, now a base for a garage, that formerly stood on arches above the outfall to the sea. Inspection of the west wall reveals the outline of three of these arches. The large storehouse of 1920, against which vessels moored, has been converted to houses and the pond is preserved as an amenity. The flood gates were rebuilt in 1977, and since they are accessible to the public, allow unrestricted observation of their ponderous yet ingenious operation. To the south is New Slipper Mill (752053) built in 1867 by a local miller Boney Hatch. The pond is now a marina, but the former existence of the mill is betrayed by the brick base of a chimney, indicating that before the end of its life in 1897 when it burnt down, it was a steam-powered mill.[51] In contrast the tide pond remains of Tide Mill, Hayling (726012), may be seen only at low water, although a brick building on the edge of the quay could form part of the original mill. An economically abortive attempt to recover gold from sea water was made here in 1908.[52]

Brewing

Arguably closely associated with food production at a time when the quality of drinking water was uncertain was malting and brewing. Because the activities were urban, their sites close to the centre of towns have largely been redeveloped, but in Havant there are a number of remarkable survivals from the Georgian era, in each case the premises having been converted to alternative uses. A malting and brewhouse of the once extensive Hammond's Brewery (715062) are in use by a local chandlery firm, and not too distant a small malting stands in a car park to the south of West Street (717062), put to use as a store by a firm of builders' merchants. The structure of Samuel Gloyne's malthouse and brewery in South Street (718061) is substantially intact, housing an electrical contracting company. Almost opposite is the much altered, small single storey malting once operated by Anne Jolliffe, now offices; inset into the wall is a datestone of 1836, but this relates to rebuilding since the original structure is much earlier.

Transport

The growth of Portsmouth was attended by increases in



road traffic, which encouraged investors at the same time to profit from the trend and to encourage further flows between towns by setting up Turnpike Trusts. The first of these was the Portsmouth and Sheet Bridge Turnpike of 1711. There then followed the Gosport, Bishop's Waltham, Wickham and Chawton Turnpike in 1758, providing Portsmouth and Gosport with improved road links with London, but not with each other, at least until the subsequent opening of the Titchfield and Cosham Turnpike in 1810. The Act of Parliament for the Cosham and Chichester Turnpike was passed in 1761. The Turnpike Acts required milestones to be erected,[53] of which many have survived. Weathering caused the original inscriptions to become indistinct and iron plates were often added. The remaining stone on Portsea Island opposite the *Market House Tavern* at Mile End (644014) has an unusual curved top to its face and bears the inscription '68 Miles to London' cut directly into the stone. By comparison the milestone at the *Red Lion* Cosham (658056), carries a plate, but the discrepancies in the information on the reverse of the stone indicate that the artefact has been relocated. The lettering on the reverse of the milestone in Mumby Road, Gosport (615001), is unclear and the plate is missing, but that set in the wall of the *Bugle*, Quay Street, Fareham (580061), declares unequivocally 'Fareham 72 miles from London, 5 to Gosport Gates'. It was usual for each Trust to have a distinctive milestone design, and this is well exemplified on the A27. To the east of Cosham, the stones at Drayton (673056) and Farlington (688058) are tiny and only marginally larger than the metal plates which are similarly inscribed. Thus at Farlington: 'Havant 2 Mile, Ports 7 Miles'. West of Cosham, at Wymering (640056) on the Titchfield Turnpike, the stone is tall but the plate small, bearing the minimum of information: 'Southton 16 Miles'. Tollhouses were a characteristic feature of the turnpikes, but largely because of subsequent road widening none has survived. Occasionally road improvement called for bridge building. Doubtless there were such structures over Port Creek and the Hilsea Lines moat, but these have several times been replaced, leaving the Wallington Bridge, Fareham (583067), as the sole survivor of the turnpike age. It is a modest brick structure of five elliptical arches, divided by cutwaters reaching to the height of the arches, but unusually with a brick bed beneath the river to prevent erosion of the piers. Coaching inns increased in number as traffic hostelries with stabling for horses developed, but the spate of rebuilding at the end of the nineteenth century, by which time the railways had totally undermined the coaching business, meant that coaching facilities were normally swept away. The coach entrances to the *Red Lion*, Fareham (582061), and the *Star*, Gosport (615998), are clearly visible, but at inns such as the *Green Posts*, North End (654032), the *George*, Cosham (667065) and the *Crown Hotel*, Emsworth (749058), the evidence is less patent.[54]

Since all the towns of the area were, with the exception of Havant, commercial ports, remnants of their functions might be expected. That this is hardly the case is a result of modifications to buildings, as in the Camber at Portsmouth (as distinct from the Camber in the Dockyard) and at Gosport, or of decline and redevelopment, as at Emsworth. In the latter instance, the shore at the end of South Street (749055) on which colliers and other coastal craft formerly beached, is unchanged, and indicative of port traffic is the *Coal Exchange* public house in South Street (749056). More tangible is the rendered warehouse by Quay Mill pond (748055); the small size of the visible bricks suggests an eighteenth century origin. At Fareham Quay (579055)

The Portsmouth and Sheet Bridge Turnpike milestone at Cosham
R. C. Riley

an excellent example of a warehouse of this period has survived, complete with half-hipped roof, S-shaped tie plates, and on the first floor, wooden framed, unglazed windows with seven closely set wooden mullions. Adjacent is a ropery, possibly of seventeenth century origin, known to have been used as a hospital in the Napoleonic Wars, and exhibiting evidence of having been subsequently widened and raised in height.

The Beginnings of Steam Industrialisation 1800–1850

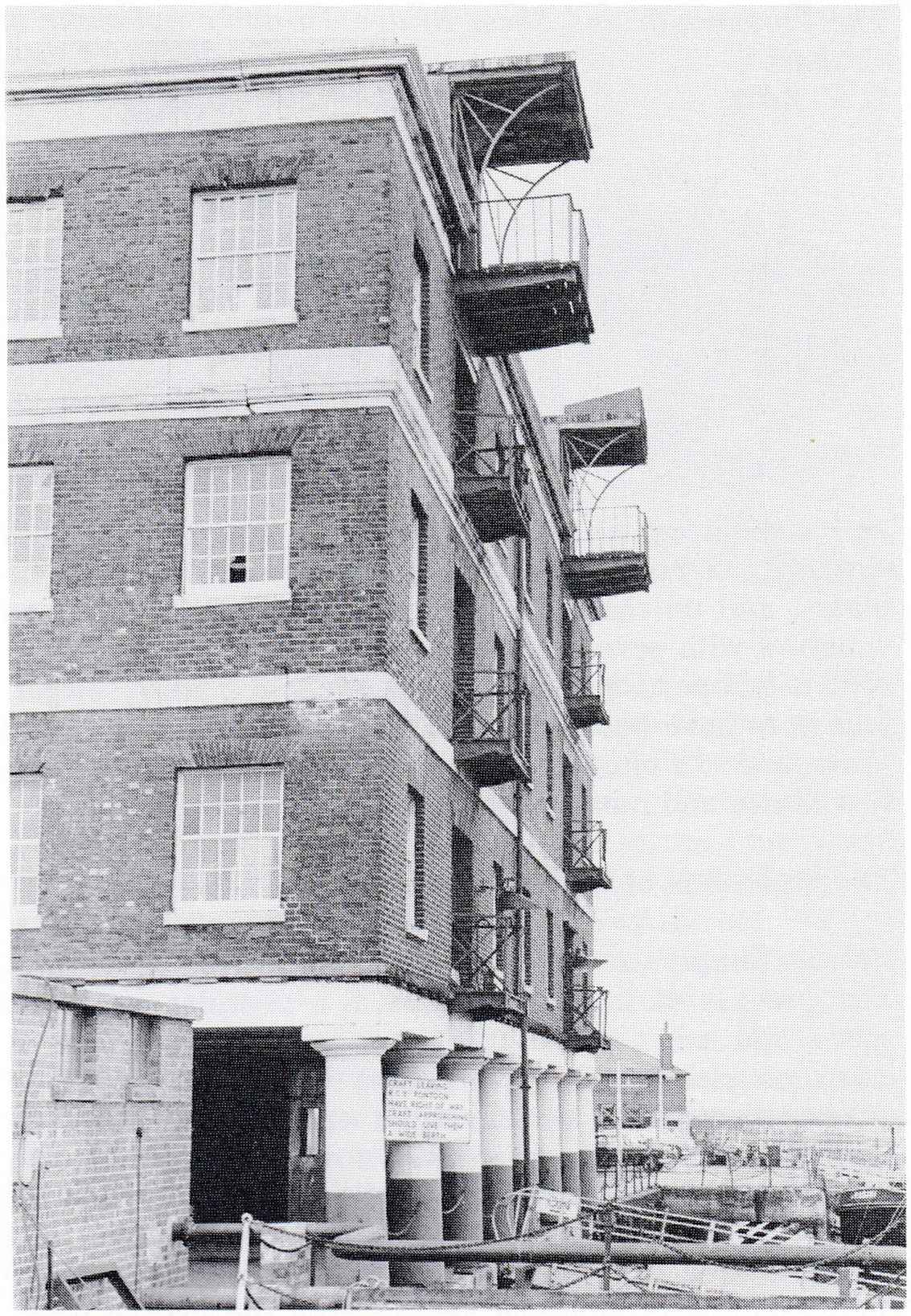
Defence Supply

The process of industrialisation is a complex issue, its speed and other characteristics depending on a host of interdependent variables, but at the technological level the development of the steam engine was of outstanding importance. Yet the Dockyard was slow to introduce steam power, and it required an unusually clear-sighted and inventive personality to seize upon the potential of the new energy source. In 1796 Bentham was given charge of the dock building programme arising from the French wars. To increase the yard's capacity for repairs on vessels not needing to be dry docked, he doubled the size of the Great Ship Basin, at the same time adding two dry docks leading from it, and installing a 12hp table engine designed by Sadler, a mechanist on his staff, to effect dock pumping in place of horse-driven gins.[55] Not only did the Sadler engine predate that of Henry Maudslay, but also it was the first use of steam power in a Royal Dockyard. For the entrance to the Great Basin Bentham introduced the notion of an inverted arch[56] which gave it a high degree of stability, and in place of the conventional gates employed a wooden caisson, the advantages of which have been rehearsed above.[57] The entrance was opened on 12th June 1801, an event commemorated by an inscription on the walls, and it remains in its original form. The wooden caisson was replaced by one of iron in the 1840s. On the north side of the entrance is one of the base plates of the 25ton capacity sheers[58] that appear on a plan of 1858.[59] Bentham's dry docks followed Dummer's principles: No. 2 which holds the *Victory*, was completed in 1802, and No. 3, now host to the *Mary Rose*, was opened in 1803. It is possible that No. 3 was given an inverted arch entrance at the time of its construction,[60] but in any case it received a near vertically sided entrance and a caisson in the second half of the nineteenth century. Outside the Basin, Bentham constructed a dock of similar dimensions giving directly into the sea; apart from a modified head this dock, No. 1, maintains its original form.

Bentham next turned his attention to the manufacture of pulley blocks, for which the Taylor family at Wood Mill, Southampton, was the Navy's principal supplier. Noting that the water level in Dummer's large basin, which had since the construction of North Dock been used as a reservoir for water from the docks, never exceeded 6ft,[61] he built the Wood Mills incorporating the Block Mills[62] on a double tier of brick vaulting therein.[63] By 1806 some 45 machines manufactured by Henry Maudslay to the designs of the gifted Marc Brunel were producing pulley blocks at low cost, constituting the world's first example of the use of metal machine tools for mass production.[64] It is also clear that the optimal location of each machine in respect of its fellows in the production process must make Bentham one of the pioneers of production engineering.[65] Four of the machines remain in the Block Mills and three may be seen in Southsea Castle Museum. It is hardly surprising that these automatic machines were sparing with labour,[65] even if the 1807–8 Muster Book for the Wood Mills as a whole lists 40 in receipt of wages.[67] Bentham was very much aware of the fire risk created by the presence of high speed machinery, wood and indeed a steam engine and boiler in the Wood Mills, and he therefore installed a water tank in the roof. In 1808 he built a wooden water tower supplying a yard ring main as a fire precaution;[68] the metal replacement of 1843, probably by Captain Sir William Denison RE, is regarded by Pevsner and Lloyd as 'a landmark in constructional history'.[69]

Not until the superiority of the screw propeller over the paddle was demonstrated in the trials between HMS *Rattler* and HMS *Alecto* in 1840[70] did the Navy introduce steam power into fighting ships. The 1843 plan, largely drawn up and executed by Denison, was the outcome of this decision. It called for the construction of a 7 acre Steam Basin and two docks, Nos. 7 and 8, which were notably longer than their predecessors; indicative of the changing shape of ships' hulls, No. 8 Dock was narrower than any other in the Dockyard. The Basin was completed in 1848, and the docks in 1849 and 1850 respectively. The pressure to provide docks of ever increasing length was ingeniously overcome by 1858 by the amalgamation of No. 7 with a further dock, No. 10, both of which could function independently through their separation by a caisson.[71] Until 1863 the use of these docks in tandem was the only way the new leviathans such as HMS *Warrior* could be dry docked in Portsmouth. The Basin entrance was found to be inadequate in the 1870s and the caisson was walled in, to be revealed during road repairs in 1984. It proved to be of high quality wrought iron, employing metal shipbuilding techniques contemporaneous with those of Brunel's *Great Britain*.[72] Both docks remain unmodified, and indeed surrounding No. 8 are still to be found mooring posts bearing the letters 'VR' by H. Grissell of the Regents Canal Iron Works, London.

With the advent of steam went the construction of build-



ings appropriate to the new age. Abutting the Steam Basin was the Steam Factory, now No. 2 Ship Shop, a dramatically handsome 600ft long structure in deep red brick offset by Portland stone cornices and pediments, by Denison. Since it was required to handle heavy equipment it was therefore narrow to avoid internal columns. The building was fireproofed, the upper of its two floors being carried on vaulted brickwork and metal joists. It was completed in 1848.[73] Motive power derived from an adjacent steam engine house, designed by Captain Henry James RE, in matching architectural style. The engine house now feeds the Dockyard compressed air grid through electrically driven Bellis and Morcom pumps. An Iron and Brass Foundry, also completed in 1848, was located on the southern rim of the Steam Basin, and the much larger Iron Foundry was brought into use in 1854 on a nearby site. Not only does the upper floor of the Iron Foundry incorporate a water sprinkler system fed by a tank on the roof, but also there is a metal staircase with cast iron panels, together with fireproof flooring throughout, representing a concerted effort to reduce fire risk. Such is the architectural similarity of both foundries to Denison's Steam Factory that it is reasonable to suppose he was responsible for their design. Both were closed in 1982. The Smithery, whose frame was constructed from remnants of the Great Exhibition and clad with corrugated iron,[74] was opened in 1852. At each corner stand the square bases of now truncated chimneys, but otherwise the structure is devoid of equipment.

The thrust of the extensions of the 1840s may have been associated with the Steam Basin, but two important buildings designed by Denison and Captain Roger Stuart Beatson RE were erected in the Georgian dockyard in 1844. The Chain Test House may have an unobtrusive exterior, but its granite and iron ballast floor, the light iron roof trusses and hydraulic accumulator together with a small petrol engine by Greenwood and Batley of Leeds render it wholly distinctive. No. 6 Boathouse designed by Beatson, on the other hand, is a powerful buff-coloured brick structure employing cast iron columns and under trussed iron girders of the kind favoured a little earlier by Robert Stephenson,[75] to support the weight of boats.[76] Of the two 90ft span iron roofs above Nos. 3 and 4 Building Slips, which predated those of the great railway stations, also part of the 1843 programme, nothing remains; they were demolished in 1980.[77]

Commensurate with these signal events were developments at the Gosport Victualling Yard, consequent upon the decision in 1827 to transfer victualling from Portsmouth to Gosport to what in 1831 became the Royal Clarence Yard. Designed by G. L. Taylor, the Navy Board architect, and built by Hugh McIntosh between 1828 and 1832, was an impressive group of deep red brick buildings with courses of Portland stone facing the Harbour. At the centre was a four storey granary mounted on cast iron Tuscan columns, its front flush with the water's

The Granary at Royal Clarence Yard, Gosport
B. F. Sprunt

A manhole cover at King's Terrace, Southsea
R. C. Riley

edge to facilitate the unloading of grain by two hoists (617006). The principle of combining a working surface with a frontage immediately above the dock wall by elevating warehouses had been employed by Telford and Philip Hardwick at St. Katharine's Dock in London in 1828, and coming so closely afterwards the Gosport granary is therefore of national significance. Long used as a store for materials other than grain, there is little interior evidence of machinery save for some line shafting brackets, and all traces of the coffee drying kiln installed in the north-west corner have disappeared.[78] Flanking the granary, set back behind the quay, were two four-storey pedimented buildings. That to the south of the granary, a storehouse, was destroyed in the Second World War. Its fellow, which remains, incorporated a bakery comprising nine wrought iron ovens[79] capable of baking a ton of bread or 10,000 hexagonal 'hard tack' biscuits per hour. Dough for the biscuits was prepared and shaped by a series of machines which were designed in 1828 by Thomas Tassel Grant, who in 1831 became Storekeeper at the Yard,[80] and built by John Rennie the younger.[81] The bakery was closed in 1907, the ovens bricked up and Grant's machinery scrapped. Behind the granary was located a flour mill designed and constructed by John Rennie, containing no less than ten pairs of stones capable of producing 500 sacks of flour per week, powered by a 40hp steam engine.[82] The engine and boiler houses have survived, the tall round headed windows of the former and the venting of the latter offering a clear indication of their original function. Also remaining are the Rum and Sugar Store of *c.* 1835 (617004),[83] although lacking its upper floor as a result of enemy action, and the Tank Store (618004), a wooden clad metal framed building constructed in 1838 by Grant, who introduced the notion of storing water on board ship in metal tanks of 40ton capacity. Ships' water was pumped to a reservoir, formerly the fishpond of the manor house, from a well adjacent to the bakery; the engine house is still intact, but whether its unusual tower was associated with the deepening of the well to 398ft in 1878,[84] or with the construction of an accumulator tower for the hydraulic power system installed for quayside cranes is unclear.

Iron Founding

The progress of industrialisation encouraged the modification or closure of the small works that were common in the first half of the nineteenth century, with the consequence that, outside government establishments, the artefacts of this era are few. Occasionally products survive, such as the manhole covers in King's Terrace, Southsea (638994), dating from the 1820s, but of their maker – Garnett & Co. of the Ferrumite Works, Portsmouth – nothing remains. Treadgold's small foundry in Portsea (633003), with its two hearths and hand-operated bellows, dates from the 1830s, although it has not worked for some years; it is fronted by a shop of truly Dickensian character, dark, cluttered, with stand-up office desks, and there is even a speaking tube to communicate with parts of the premises.

Agriculture

Because the speed of change in agriculture was slower, artefacts are much more abundant. It was a time of transition between wooden and brick or flint buildings as the comparative costs of materials changed. Both slate and galvanized corrugated iron became available in the 1830s, although the latter was introduced only slowly. The four bay aisled barn at Northney Farm, Hayling Island (731037) is constructed of timber with a slate roof, while that at Church Farm, North Hayling (730030) is likewise timbered and its three bays aisled, but it has a hipped corrugated iron roof. Mechanical threshing removed the need for the characteristic canopies of the earlier barns, and the knapped flint barn at Southwick (621088) lacks these features. More typical of the region is the brick walled, slate roofed barn at Dairy Farm, Purbrook (682076), where timber is still employed for the four bays, but there are no canopies. Model farms with a rationalised layout, often designed by architects, were attractive to the landed gentry of the times; the buildings on the Leigh Park Estate Farm (722084), owned by Sir Thomas Staunton between 1828 and 1858, form a good example of the genre.

Transport

Despite the existence of the turnpike road network, which, with its system of feeder roads, became increasingly sophisticated during the first half of the nineteenth century,[85] the region relied very much on coastal shipping for the movement of goods, assisted by the construction in 1823 of a small lighthouse still standing at Southsea Castle (643980). In retrospect, therefore, the opening of the Portsmouth section of the Portsmouth and Arundel Canal between Landport and Langstone Harbour in 1822 was particularly short-sighted.[86] Traffic proved to be slight and moreover there was troublesome seepage of its saline water into wells along the route. As early as 1825 the Portsmouth Barge Co sold its fleet of boats, and the venture was closed in 1831. The sea lock, capable of handling 150 ton sailing barges and consequently of generous proportions, remains in surprisingly good condition, although the gates have disintegrated and the capstones been dislodged (678999). Brick remnants of the second lock 100 yards inland of the first are discernable in a small boatyard (676998), while the unmistakable tall, slim outline of a beam engine pumping house used to maintain the water level in the canal is visible amid more conventional houses

in Waterlock Gardens (675998). The towpaths and canal bed are readily traceable westwards to the *White House*, Milton Road (665995), and at the point where it formerly crossed the canal on a swing bridge, thereby facilitating the passage of sailing barges,[87] Ironbridge Lane noticeably narrows and rises above the level of the surrounding ground (670998). To the west of the *White House*, the canal bed lies beneath Goldsmith Avenue, but quite remarkably, in the front gardens of two private houses there are traces of the hawthorn hedge that lined the southern bank. Since the hedges do not even constitute a natural boundary their survival is nothing short of miraculous. Save for the road Canal Walk flanking the northern bank (646002) beyond Fratton Bridge (651000), the railway, which bought the land from the canal company, has successfully obliterated all signs of Portsmouth's short lived inland waterway.

Although it did not achieve more than an incipient impact until the second half of the century, by 1850 the railway had at least linked the towns of the area to each other and to the nation. The London and Southampton Railway opened their magnificent station at Gosport (614002), designed by Sir William Tite, in 1841, his fourteen bay Tuscan colonnaded building representing one of the outstanding stations of the early railway period in Britain.[88] The line was extended through the fortifications of Royal Clarence Yard in 1845 to allow the construction of a small station and waiting room (618004) for the convenience of Queen Victoria and her retinue. The valance of the roof, supported by slender iron trussing, serves to identify the building which has been incorporated within a more recent structure. The iron window frames were formerly graced by a royal crown, but these have fallen prey to predatory collectors.[89] Fareham station (569062), opened in 1841, was a tiny stone structure with tied chimneys reminiscent of Tite's Gosport, and a platform canopy carried on five slender iron columns which may still be seen; it was greatly extended in 1889. In continuing the line to Portsmouth in 1848 the company, now the London and South Western, constructed the 11-arch brick Quay Viaduct at Fareham (580059) and the even more impressive 17-arch Cams Viaduct (587062) over the River Wallington and the former pond of Cams Tide Mill, a feature of which are the false arches flanking the skew arch taking the road. To the east, high on an embankment, the station at Portchester (616058) was erected in the same year. Not only does the use of flint and the presence of delicate iron canopy brackets render the building an attractive piece of railway architecture, but further distinction is derived from the need to reverse the normal arrangement whereby the station master lived above the waiting room and ticket office.[90] The 1848 station at Cosham (658051) was constructed in the cottage *ornée* style, the entrance being through a short wooden arched and panelled passage which is still in situ. In contrast, the adjacent platform canopy is carried on eight unadorned metal columns and simple curved bars. An attempt has been made to replicate the decorative wooden spandrels of the main entrance in a section of the south side platform canopy supports, suggesting that this may date from the opening of the line. Dated artefacts demonstrate that general improvements were undertaken in 1878, 1881, 1884 and 1890.[91]

The London Brighton and South Coast Railway opened a station in Portsmouth (641002) in 1847, having secured military permission to breach Hilsea Lines and to cross Port Creek by a bridge, the later version of which could be raised by a pair of enormous metal legs to deny the enemy access to Portsea Island.[92] The station building was in stark contrast with Tite's fine edifice at Gosport, and doubtless represented the railway's view of the social and even economic importance of the town. Indeed, a railway publication went so far as to declare that 'Everything looks, breathes and smells of soldiers, sailors and dockmen, the three classes who rule the state of society here'.[93] Fay described the station as 'a miserable structure . . . the booking office and waiting room were constructed of deal boards lined with canvas; and every part of the station was of like character'.[94] For once change was justified. The replacement of 1866 destroyed all vestige of the original, whose entrance lay to the south of the tracks,[95] not too far distant from the appropriately named present-day Dugald Drummond Street.[96] The present Havant station (718065) dates only from 1938, but the original station building at Emsworth (748064), opened in 1847, survives, even if ev-

A knapped flint and brick barn at Southwick
R. C. Riley

erything else, including the awning over the platform with its 'loping' valance[97] and columns by Every of Lewes, dates from the 1880s. The Brighton company built their level crossing keepers' houses to a uniform design, notably including hood moulds above the windows, and some are still standing, as, for instance, those at Copnor (660014) and Havant (720065). Of the lineside structures undoubtedly the best is the delightfully sinuous 21-arch brick hump backed bridge (702062) carrying the road to Bedhampton Mill, whose owner insisted on a high quality structure in compensation for loss of amenity.[98]

The arrival of the railway in Portsmouth had important implications for the Dockyard, as both companies, who formed a joint committee to control their operations on Portsea Island, were quick to appreciate. A single track line was therefore extended from the Town station in 1849, crossing Commercial Road on the level and breaching the fortifications of Portsea at their northern extremity. This branch was relaid to main line standards in 1857,[99] and the metal level crossing gates at Edinburgh Road (640005) and Alfred Road (639006) date from this time. Metal castings bearing arrow head markings were used to provide an improved union between the track and the road surface. Within the Dockyard the railway served the buildings and docks in the vicinity of the Steam Basin, tight curves being avoided by the plentiful use of turntables. At the same time the system of flat granite slabs, introduced to ease the movement of trucks over what was otherwise a very uneven suface, was modified by the introduction of railway track. Captain James, who designed the system, provided the trucks with wheels capable of working on both the granite 'tramway' and the standard gauge railway network.[100] The subsequent extension of the railway system and modern road surfacing have obscured this interesting piece of transport history.

The Full Flood of Industrialisation

Defence Supply

The age of steam and iron that so altered the Dockyard in the 1840s diffused through the whole region in the second half of the century, yet because of the rapid strides that were being made in shipbuilding technology, to say nothing of propulsion methods and the nature of gunnery, major changes were undertaken once more in the Dockyard. It should be emphasised, however, that the overriding impetus for change filtered down from Whitehall and Westminster where the threat of war with France in the 1860s was perceived as a reality. The Portsdown and the Spithead Forts were a further manifestation of official thinking. Similarly, although with greater justification, Germany was later seen to be the potential aggressor, giving rise to a further round of Dockyard extensions to underpin the era of the Dreadnought.

In 1864 the Admiralty obtained parliamentary sanction for extension works beginning in 1867,[101] which trebled the area of the Dockyard, some half of the new ground, or 95 acres, being reclaimed from the Harbour.[102] Three enormous basins, each larger than the Steam Basin, were constructed for fitting out, rigging and repairing,[103] access to the Harbour being through North and South Locks. On the south side of the Repairing Basin two docks, No. 12 and 13, were built, while a third, Deep Dock or No. 9 opened into the Harbour. The three docks and two locks were of similar dimensions, but in place of the now standard caissons, sliding versions were fitted to Deep Dock and the western ends of both locks.[104] The scheme, which included a pumping station, was largely completed in 1876, the Fitting-Out and Rigging Basins not being ready until 1881.[105] Provision was made in the plan, drawn up by Colonel Sir Andrew Clarke RE, for two further docks, Nos. 14 and 15, issuing into the Repairing Basin, and these came into use in 1889 and 1897 respectively. Such was the increase in size of warships that all four docks on the south of the Repairing Basin had to be lengthened,[106] and to improve access to them two further locks, C and D, were constructed, and the walls separating the three basins removed to create a single, vast, prosaically termed No. 3 Basin. Appropriately as it transpired, the work was finished in 1914. Apart from the demolition of the 250ton cantilever crane,[107] which graced the Portsmouth skyline between 1912 and 1984, and the installation of modern cranes, this entire complex remains unaltered.

Despite the completion of what was known as the Great Extension in 1881, most of the buildings associated with the new capacity were completed subsequently rather than simultaneously. One exception was the Armour Plate Workshop, later No. 1 Shipshop, opened in 1867 and owing much in style to the buildings of the 1843 plan, although the twin towers flanking both north and south entrances are certainly Italianate – a new direction for Dockyard structures. Adjacent is the accumulator tower of the hydraulic power system used for lifting heavy weights in the Workshop. Many of the new buildings reflected the new directions in naval architecture. The Gun Mounting Shop of 1886 was characterised by six bays each of which contained an overhead travelling crane employed for moving the very heavy guns of the period. The Torpedo Shop of the same year was notable for three gables bearing intricate low relief work, one of which remains. Outside is a rare survival from the railway age, a standard gauge turntable. The single storey Painters' Shop, dating from the 1880s,[108] received handsome gables edged with Portland stone, and entirely functional in na-

ture, the 1891 Mould Loft, where full-size templates of ships' plates were fashioned, had its first floor roof carried on two broad spans to minimise restriction to the work in progress. Constructed immediately prior to the Dreadnought programme, the Factory of 1905 is a vast, five bay steel framed workshop, and like so many twentieth century industrial buildings its external appearance is unrelated to its internal functions.

Power for the new structures was initially supplied by steam engines or hydraulic pressure,[109] but the advantages of electricity were such that a power station was built in 1903 for the Factory, followed in 1906 by a much larger plant, the moulded base of whose chimney survives. Gas supplies were provided by the neighbouring Flathouse works and were metered in the quite striking ambience of the stone tower at the southern end of Frederick's Battery, a seventeenth century defence work relocated during the Great Extension.[110] Concomitant with change in shipbuilding production went development in the railway system in the yard, a network which at its peak claimed 25 miles of track. Curved track replaced the cumbersome turntables wherever possible, and a small brick engine shed was put up to service the Dockyard locomotive fleet. The opening of the Portsmouth Extension Railway in 1876, running on an embankment between the Town and Harbour stations, caused the Dockyard branch to be realigned in Victoria Park; the double armed signal post which still stands at Edinburgh Road probably dates from this time, although the line closed in 1980. A second single track line into the Dockyard was built between the Harbour station and South Railway Jetty in 1876.[111] The legacy of the line are the two metal piers of a swing bridge formerly sited adjacent to the Jetty, a waiting room complete with a railway style canopy and valance, and the Royal Shelter of 1893, its elegant smoke vents and intricate finials a riot of colour, now greeting ships' crews rather than railway passengers.

Developments in naval establishments elsewhere lacked the scale of those in the Dockyard, but certainly in one instance they were none the less innovatory. Following on from his father's pioneering work, in what is now the Admiralty Marine Technology Establishment, Gosport (615987), in 1886 R. E. Froude constructed a ship model test tank which was used to test all naval vessel designs until 1945.[112] The original tank, 145 metres in length and 6 metres in width, is still in place, as is the building with its king post trussed roof. In a small museum devoted to the work of William Froude are a section of the original carriage and a model of the steam engine, by Beauchamp Towers, employed to move it, a propeller dynamometer, a ruling machine developed between 1873 and 1875 for the production of squared paper, two models used to calculate the efficiency of ships' bows dating from 1867, and another built in 1872 for the measurement of the resistance of ships' hulls. Perhaps of less scientific import but unquestionably of great operational significance was the boat handling mechanism in the adjacent Gun Boat Yard (616990). The date of the Yard's construction is uncertain, but it was working by 1859 when it was referred to as the New Slipway and the boathouse capable of accommodating 120 gunboats in addition to mortar boats.[113] In essence boats could be hauled up, or launched, at any state of the tide by means of a mobile platform known as the Elephant, on which was mounted a trolley which in turn

Sir William Tite's elegant station at Gosport
R. C. Riley

carried the boat. Thus the trolley and cradle could be placed beneath a boat which would settle as the tide ebbed, then drawn on to the Elephant, which would move on rails at right angles to the slip, before being discharged from the Elephant into the boathouse. The cradle would be chocked up, the trolley withdrawn and keel blocks placed beneath the vessel. The Elephant was effectively a locomotive, its journeys along the transverse slipway being powered by a steam engine mounted on the working deck; the movement of the trolley on the Elephant was achieved by a wormscrew approximately 100ft in length.[114] An idea of the scale of the system may be derived from the dimensions of the transverse slip which was 400 yards long and 45 yards wide; the length of the Elephant must therefore have been at least 45 yards, a mobile structure of quite remarkable contemporary proportions. The transverse slip was later greatly reduced in length and the Elephant scrapped in the early 1970s, but the 300 yard long boathouse has survived.[115]

Since there was less scope for the introduction of new methods of handling ships' provisions, developments at the Royal Clarence Yard were more muted. The principal development was the Slaughterhouse, planned in 1854 and probably completed by the end of the decade (618007); its red brick structure and large round-headed windows match contemporary buildings in the Dockyard. To assist in ventilation there is a louvred clerestory in the roof, the wooden tie beams carrying the latter being supported by wooden columns and, adjacent to the walls, by wooden braces laid on Portland stone buttresses. The strength of this arrangement stemmed from the need to suspend carcasses and later from the installation of a monorail system for the movement of meat about the building.[116] On the wharf outside is a small iron manual crane for the transfer of meat to lighters. Single storey brick cattle lairs remain to the west of the Slaughterhouse. Beyond is a truncated chimney of an electricity power station (617007) dating from the Edwardian period when large enterprises could economically produce their own supplies. An original electric lamp standard by Hardy and Padmore of Worcester stands in Flagstaff Green behind the impressive entrance to the Yard.

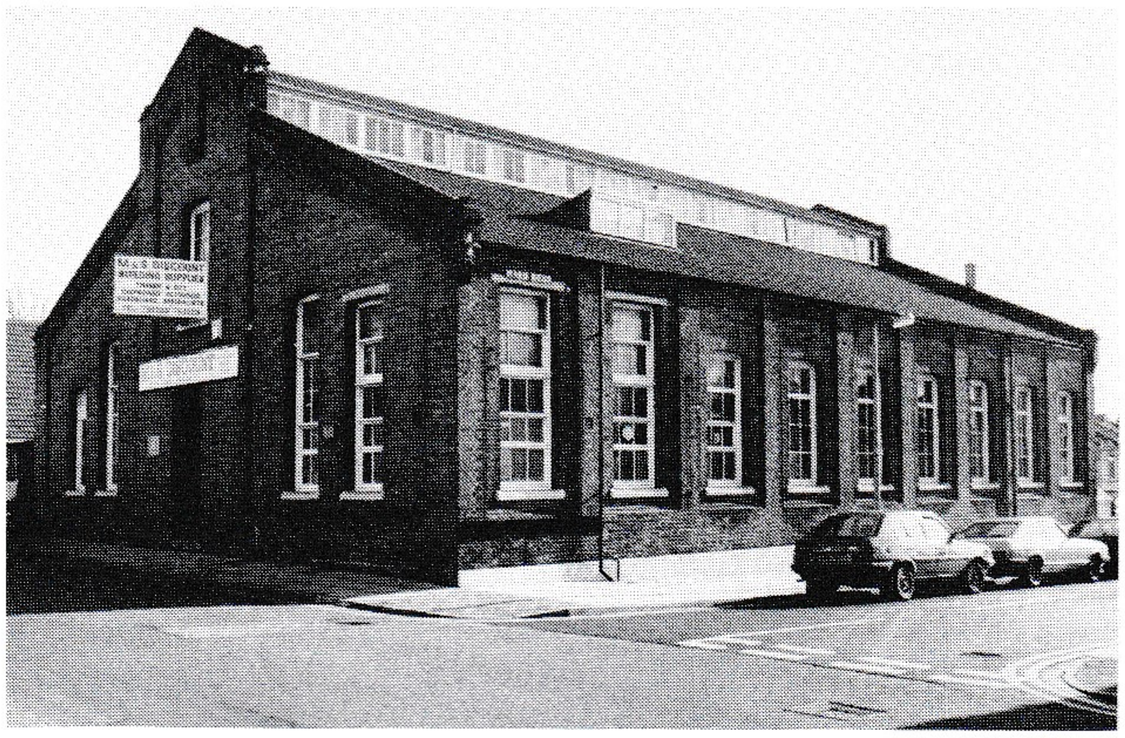
From 1889 the testing of torpedoes was carried out on a long artificial lake at Horsea Island, itself an amalgamation of two islands[117] (630046). Such work has long been undertaken elsewhere but the lake, the sluices at its western extremity, a double patent slip comprising two tracks which merge seawards into one, and a metal bollard confusingly dated 1854 remain. Torpedoes were handled by means of a five ton Ransomes and Rapier hand crane which is unusual in having a traversing mechanism in addition to lifting capacity, reflecting the need for care in the transshipment of such cargo. Remnants of the island's narrow gauge railway are visible, and a tank house dated 1915 completes the inventory of this location which is now part of the Northarbour reclamation scheme. To the south, Whale Island was gradually built up from spoil excavated from the Great Extension of the Dockyard and afterwards, the last load being dumped in 1895 and the railway viaduct demolished the following year.[118] The island was for many years the Royal Navy's gunnery school, H.M.S. *Excellent*; the principal relics are a small red brick magazine with Portland stone trimmings of 1893, having the air of an elaborate boathouse rather than the very distinctive structure at Priddy's Hard, the base of a nearby crane built on piles in the seabed[119] (634019), and some short lengths of standard gauge railway track near the proof butts (634020). The hardway to the mainland opened in 1891 is visible at low tide, although the manually operated swing bridge which replaced it itself gave way to a fixed link in 1974 (640022).

Water Transport

Possibly because of the very importance of naval shipbuilding, coupled with government control of much of the Harbour foreshore, commercial shipbuilding and repair was an insignificant activity at this time.[120] Lacking a railway link with the main line, initially because the Portsmouth fortifications were regarded as inviolate, and later because the Admiralty was reluctant to sanction a development which might generate undue shipping in the Harbour, Portsmouth could hardly be expected to spawn large scale port activities.[121] The Camber dry dock (631996), with stone stepped sides and a caisson gate similar to those in the Dockyard, was opened in 1863 to encourage repair work, but for many decades was simply used by colliers delivering supplies to the power station. Since 1983 it has lain beneath the ferry port car park, even if its entrance is still discernible. Rather than as a site for manufacturing, the Camber's first purpose was that of a transhipment point, and most of the older artefacts, such as iron mooring posts and roller fairleads, some of which bear the date 1861,[122] are concerned with this function. Appropriately in the local context, surplus cannon have also been pressed into service. The steel framed, wooden clad transit sheds are early twentieth century, and adjacent to the *Bridge Tavern* (631995), which marks the location of a former swing bridge across the Camber demolished in 1923, are concrete remains of the once extensive coal bunkers and concrete supports for overhead gantry cranes dating from the inter-war period. The distinctive double fingered bollards by the firm of Bean are of more recent origin. The small quay at Flathouse (641014) built by the Corporation in 1921 has always had a purely transship-

The Marina Corset Factory, Highland Road, Southsea
R. C. Riley

Water pumping at Havant; original managers' house in foreground, also A. E. Cogswell's engine house of 1927
R. C. Riley



ment function, while both Clarence Pier (634988) and South Parade Pier (652980) were originally constructed in 1861 and 1879 respectively to derive an income from passenger traffic to and from the Isle of Wight. Manufacturing has not been entirely absent from the Camber, where Vosper's yard is still working (630994), its main slip comprising three tracks, the central one of which has a ratchet surface to mesh with pawls on the cradle, thereby preventing an unpremeditated launch. The Harbour Ferry Co's sizeable patent slip at Ferrol Road, Gosport (610006) is now being used by the Steam Launch Preservation Group, but the large and strikingly gabled Camper Nicholson & Ratsey's sail loft in Quay Lane, Gosport (622999) is no longer used for this purpose, and the patent slip at Emsworth (752055) is derelict. Built of the rich red local brick, the water-side granary at Fareham Quay (579055), completed as recently as 1912 and thus indicative of the relative prosperity of the port at the time, may have retained its gantry above Fareham Creek, but it is now the premises of a firm specialising in pleasure craft accessories. However, the reuse of industrial buildings in this way is vital if they are to survive.

Engineering
Largely because of the policy of self-sufficiency followed by the Admiralty, the strength of the engine builders on the Thames, Tyne and Clyde, and the concomitant absence of manufacturing contracts between Portsmouth and its Dockyard, engineering was weakly developed in the town. At Mile End (643016) is McKinley's, the largest survivor, a firm in business in the 1850s. A wooden frame has been added inside the walls of the oldest building to help support the first floor, and the works are a treasure trove of inter-war machine tools.

Clothing and Textiles
More important, especially in Portsmouth consequent upon the availability of large numbers of military dependants, was the clothing industry, with corsets the principal specialisation.[123] The Marina Factory, Southsea (662989), built in 1897, the Kingston Factory (650017) in 1904, and the Goldsmith Avenue Factory (657998) in 1921, form the residue of this industry, although none is engaged in corset manufacture at the present time. With the exception of the last named works, whose north elevation is unusually decorative with Portland stone quoins and string courses together with a pediment, they are unprepossessing brick premises notable chiefly for their large windows to admit the maximum amount of light; indeed the clerestory which furthers this aim is the most distinctive feature of the Marina Factory. On a very much smaller scale is the Hampshire Corset Co. which employs a dozen operatives in Fratton Road (650015), and which was established in 1899. There are a number of hand-worked machines still in use, including two eyeletting machines by Newey Brothers of Birmingham. The former cap factory in South Street, Havant (718061), bears a strong resemblance to the Portsmouth corset works. Rather smaller is Alfred Stent's former glove factory dating from 1916 in West Street, Havant (714063). The formerly long, slim single storey sacking factory in Emsworth (752054) has been reduced to half its size by the pressure on land for housing, but through its present use as a tent store it remains related to the textile trade. Arguably once Havant's most celebrated industry, the manufacture of parchment, has left little imprint, the remaining works at Homewell (716061) being both small and much modified; production ceased in 1963.

Brewing
The presence of the Dockyard and the garrison ensured that brewing was a leading activity in the area. The size of Whitbread's premises in Portsea (632005) is evidence of this, although it is also in part the result of the entrepreneurial acumen of the Jewell family and later the Brickwood brothers.[124] Because of piecemeal expansion since 1840, it is an amalgam of assorted buildings, converted dwelling houses, some of whose exterior windows and walls are subsumed within other structures, the gable end of a nonconformist church, and the entrance to Jewell's brewery entangled among other masonry. Some of the equipment belongs to the early years of this century, notably two tall coppers whose bases are clad in white glazed brickwork. Brewing terminated in 1983, as it had in other local breweries decades earlier. Relics include the structure of Young's Victory Brewery, Landport (641008), the derelict Wallington Brewery, Fareham (585069) built in 1888, and the disused Golden Lion Brewery at Southwick (626085), containing a full set of equipment, despite closure in 1956. A comprehensive restoration programme has been undertaken at Southwick, culminating in a commemorative brew in June 1985. It is an excellent example of what was a common mid-nineteenth century phenomenon, a brewery supplying a single public house.[125]

Other Industries: Tanning, Brickmaking and Grain Storage
Tanning may never have employed as many as brewing, but its buildings were at least as distinctive with their wooden louvres to promote the drying of hides. Two re-

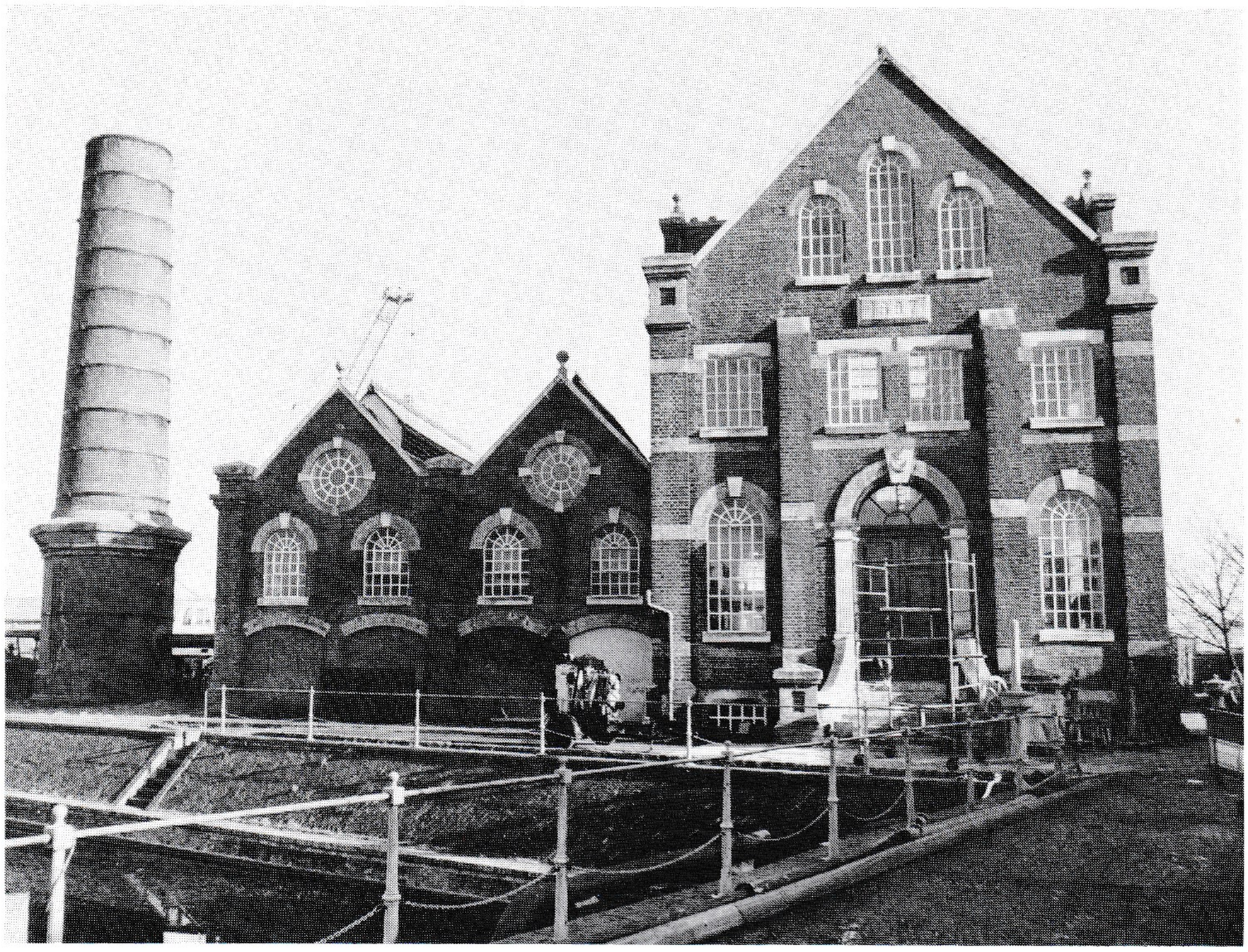
maining examples are those at Copnor (660013) and Havant (710062), although the latter premises are used as a store by the Portsmouth Water Co. The Fareham area was once noted for the manufacture of bricks, their use in a number of celebrated buildings such as the Royal Albert Hall testifying to the quality of Fareham 'reds'; however, the remains of the activity are now negligible. A small scale working example of brickmaking by the clamp method[126] from local clay is found at North Hayling (717030). That many Portsmouth houses are made of bricks produced in this fashion gives Pyecroft's Brickworks particular relevance even though the enterprise did not commence until 1934. More enigmatic is the nature of the works at Bedhampton (703062) whose sole surviving artefact is a standard gauge railway wagon turntable formerly linked to the main line, but now isolated in a meadow. There is support for the view that the factory manufactured biscuits in the presence a mere 100 yards distant of a granary in attractive polychromatic brick dated 1868, now in athletic use as a squash court.

Agriculture

In a sense it is somewhat arbitrary to argue that agriculture underwent radical change in the second half of the century, at least in respect of its surviving buildings, for the pattern had largely been set in earlier years. The classic rectangular yard form is found at Ham Farm (616086) and at Model Farm, Waterlooville (684090), built in the 1860s, albeit a very much smaller scale version of earlier prototypes. Hookheath Farm (648080), Cutlers Farm (663096) built in 1855, and Sheepwash Farm (657095) with an 1856 datestone, all exhibit only slight divergence from the architecture of earlier years in having sliding doors to their brick barns. Widley Farm (662070) possesses an open fronted cartshed with a loft and dormers above, but this was hardly a new departure. Equally, Ashleydown farm's collection of wooden buildings (609082) have the appearance of having been built after 1850. Tangible evidence of the changes which swept West European agriculture during the last quarter of the nineteenth century following the arrival of low cost grain from the New World, is the Danish Bacon store at Fratton (655999). The Danes were quick to diversify out of grain into dairy and pig produce, setting up marketing organisations abroad. Like the Slaughterhouse at Royal Clarence Yard, and for the same reasons, it is a single storey building, the bricks in the window sills providing a date of 1895.[127] At a more parochial level, the wooden stumps of oyster storage ponds may be seen on the beach at Emsworth (751054), the residue of an industry that died overnight in 1902 when three worthies expired after consuming Emsworth oysters at a banquet in Winchester, an inevitable result of untreated sewage issuing from a nearby conduit.

Public Utilities

After mid-century public utilities were greatly improved in response to both market forces and humanitarian pressures. The supply of drinking water was obviously critical and was first to be developed, the brick walled Drayton Basin (678058) opened in 1812 by the Portsmouth, Portsea and Farlingon Water Works Co. being the oldest surviving artefact of the many that have been involved in tapping the natural springs below Portsdown. Adjacent is a small pumping station installed in 1905 to supply water to the George Reservoir at the top of Portsdown Hill; it is not now in use. Of the 1860 pumping station at Havant (710063) only the gatehouse remains,[128] but the adjoining horizontal steam engine houses at Bedhampton (706063), brought into service in 1889 and 1902, are intact. The large terra cotta brick pump house of 1927 by the local architect A. E. Cogswell[129] at the Havant site is still operational, and electric motors rather than the original Worthington Simpson triple expansion engines provide the power. A single storey pumping station housing Brush horizontally opposed diesel engines was built at Bedhampton (704062) as a stand-by precaution in 1939. Gosport Water Works established their pumping station at Bury Cross (598995–6) in 1859, 'For supplying the town of Gosport and Neighbourhood with PURE WATER', as a plaque on the building proclaims. The station, now devoid of equipment, has a single storey with a distinctive crenelated roof line; contiguous is the extension of 1874, also empty. Opposite is



the tall 1884 beam engine house which unusually contained a single rather than a pair of engines. The beam floor is still in situ, as are the iron supports for the beam, carried on a massive wooden joist. Pumping on the site ceased in 1907,[130] and the water tower of 1866 – a well known Gosport landmark – demolished in 1975. The red brick, gabled engine house at Stoke (720020) was built in 1895 by the South Hayling Water Company above a well to supply the southern part of the island. Smaller pumping and booster stations in the region are those at Maindell, Fareham (588070), Drayton (678058), opened in 1905, and Portsbridge (655047), completed in 1929. Improved standards of purification were reflected in the construction of large filtration beds in 1909 at Farlington (683061).[131] Rich red brick towers containing clockwork Venturi water meters by Geo. Kent of London marked two corners of the beds; one of these elegant machines was salvaged when the whole plant was modernised in 1982 and adorns the new control building. The works was extended in 1924, and one of the beds, complete with washer house and narrow gauge manually operated railway, has been preserved.

Gas manufacture began in Portsmouth as early as 1821, but the remains of the early works are vestigial, save at Havant (721066), where two of the original buildings of 1856 are used by a construction firm.[132] The works were closed in 1926. The Hilsea works (664029) were opened in 1904, but with the exception of two spiral guided gasholders, a few buildings and offices at the entrance, the relics of the coal gas era are not numerous.[133] Despite its location on the main railway line, in the inter-war period the works secured their coal from colliers berthing at Flathouse Quay, whence it was hauled across the island by a fleet of steam lorries. Elsewhere twentieth century gasholders comprise the conspicuous remains of works at Fareham (585059), Gosport (615993), where one of the holders is the only column-guided example in the region, and Emsworth (749061). Gas was not made on the site of the holder at Havant (726075). Evidence of the fine column-guided holder of 1872 at Rudmore (644017) is restricted to a section of the wall, complete with ornamental tower at the northern end, erected to shield it from the view of nearby middle class residents.[134]

A series of severe cholera epidemics coupled with encouragement from parliament led to the installation of a comprehensive drainage system in Portsmouth in 1868. Sewage moved by gravity to Eastney (673992) where a pair of Clayton beam engines raised it into an outfall pipe. The engine and boiler house, which resemble contemporary structures in the dockyard, are now used as a workshop, and the fluted metal columns which supported the beams are in place. A pair of Watt compound beam engines[135] was installed in 1887 to cope with the increase in the town's population, and the height of the engine house reflects their size; the building exhibits the ostentatious civic architecture of the time. Simultaneously brick holding tanks, whose roofs were grassed over, disguising their function, were established near the shore (684993) to allow sewage to be held and expelled shortly after high tide, so assisting in its dispersal. The tanks were ventilated by a tall chimney, still in situ. Initially the outfall sluices were operated by simple water turbines, but the system was later modified to work by hydraulic power, pressure being derived from a small Crossley petrol engine and pump.[136] Subsequent addition to pumping capacity was achieved through the installation in 1904 of three horizontally opposed Crossley gas engines in nondescript premises chiefly notable for the size of the cooling water tank.[137] Electric engine houses were introduced in 1922 and 1939.[138] Fort Cumberland pumping station (674992),

The beam engine house at Eastney pumping station
R. C. Riley

Gosport's Penfold pillar box outside the railway station
R. C. Riley

housing a Ruston and Hornsby diesel, was built in a nearby bunker in 1942 as a wartime contingency. Of the booster stations, that at Copnor (659026) is the oldest, being constructed in 1909 with gas engines to work the pumps; it was extended between 1928 and 1933. The others, at Tipner (641029), Port Creek (660045) and Cosham (664049), have electric motors and date from the 1930s. Both Tipner and Port Creek are tiny stations, but Cosham comprises four buildings, the largest of which is of architectural merit having corbelled gable ends with a semi-circular window and keystone. Mainland pumping station, Farlington (673047) was opened in 1956; it is unusual in having a settling pond and mechanical dredger on the site, while standing incongruously outside is a structure redolent of a telephone kiosk containing a Lea Recorder for the measurement of flow.[139] The recent demolition of Portsmouth Power station at the Camber dock (632996), where electricity supplies were first generated in 1894, leaves the minute generating station at Fareham Quay (578057), operational between 1897 and 1932, as the sole survivor of an industry whose product effectively put paid to the viability of steam power.

Transport

Much of the present-day railway system was constructed in the second half of the century, and quite apart from the modifications to stations referred to above, new stations were built and further lines laid down. The most diverting structure is Portsmouth and Southsea station (641002), completed in 1866 in the eclectic style favoured in the high Victorian period. Polychromatic or multi-coloured brickwork, decorative keystones and masonry with incised designs vie with French turrets and intricate wrought-iron patterning in the *porte cochère* for the attention of customers. The ironwork of the train shed is by the Regent Foundry, Brighton. The High Level station, mounted on a viaduct of iron piers, is by comparison cramped and functional, but at least it is distinguished by roof brackets bearing the intertwined letters 'PER' of the Portsmouth Extension Railway, opened in 1876 after the removal of the Portsea fortifications made possible access to the Harbour. The line ran on an embankment to Portsmouth Harbour station (629000) to avoid level crossings, two additional bridges being required to meet military demands for access to Victoria Park from officers' quarters at that time located to the south (640002 and 638001). The Harbour station was itself rebuilt in 1937 and bears the unmistakable curved stucco of inter-war styling. There is scant evidence of the Stokes Bay Railway and pier, opened in 1863 to facilitate access to the Isle of Wight, although its path may still be traced; two metal bridges appear in Alverstoke (606986 and 607993). The metal piers of the manually operated swing bridge linking the wooden viaduct spanning Langstone Harbour (718042), together with the concrete piers of the base of the viaduct, are, with the warehouse at Hayling (709997), the principal artefacts of the Hayling Island line, opened in 1867. Another project endeavouring to capitalise on tourist traffic to the Isle of Wight was the East Southsea Railway, which operated between 1885 and 1914.[140] Its Granada Road Terminus (650984) is surprisingly well preserved, having been incorporated into Wadham Stringer's garage, land taken up by a former road bridge over the line has given rise to Devonshire Square (657995),[141] and at the railway's junc-

tion with the main line at Fratton (653000) a sizeable if uninspired station with ironwork by W. Richards & Son of Leicester has developed.[142] At Langstone (718044) wooden piles driven into the foreshore betray the location of the ramp used by the Isle of Wight train ferry, the paddler *Carrier*, between 1884 and 1888.[143] Of the station at Farlington, initially opened in 1891 to serve the adjacent racecourse, closing in 1937, only a portion of an associated goods platform has survived (676048). Underlining the thesis that railways opened towards the end of the nineteenth century were economically marginal, the Lee-on-the-Solent Light Railway which opened in 1894, lingered only until 1935, its terminus now ignominiously an amusement arcade (562004).[144]

Closely parallel with the growth of the railway system was the emergence of street tramways, initially using horse-drawn cars, and later electric traction. Tramways ran in Portsmouth between 1865 and 1936, electrification taking place in 1901, yet for a network that achieved considerable complexity, surprisingly few artefacts exist. There is a section of interlaced track preserved in granite setts, together with a traction pole, in Rugby Road, (651998) near Fratton Station,[145] a short length at the former Broad Street terminus in Old Portsmouth (629996), and at the Eastney bus depot Eastney (665990). Track is also visible at the Hoeford depot (579046) of the Gosport and Fareham company which operated trams between 1905 and 1929. The abutments of a bridge over Southwick Hill Road (658058) and a traction pole near the *George* (669067) testify to the existence of the Horndean Light Railway, a tramway that worked between Cosham and Horndean from 1903 until 1935.[146] Many traction poles, by McElroy of London, still exist in Portsmouth, having been subsequently used for trolley buses until 1963,[147] and then as lamp standards. Some tram shelters persist, most remarkably that at Cosham (656050), formerly sited in Guildhall Square. Other items of street furniture are a commentary on the gradual improvement in urban amenities in Victorian times. They include pillar boxes, such as the fine hexagonal 'Penfold' example at Gosport station (614002) by Cochrane Grove & Co of Dudley,[148] and gas lamp posts, exemplified by that made by Macfarlane of Glasgow in St. Faith's churchyard, Havant (717062). Many gas lamp posts by a variety of Portsmouth founders such as Sperring, Cash and Evans, whose works are no more, have been converted to electricity, and there are a number of large, ornate electric lamp standards such as those on the Southsea sea front (653981–674989) and those in Fareham High Street bearing dates between 1897 and 1903. Even small junction boxes, such as that set unobtrusively into a wall at Havant (715063), carrying the words 'City of Portsmouth Electricity Undertaking', provide reminders of the changes that have taken place in the generation of electric power. The 1902 horse trough in George Street, Fratton (658014), is indicative of the former importance of horse power in road transport. Water supply and drainage grids, many incorporating the Portsmouth crest in addition to the maker's name, abound, but however mundane, they are nevertheless an integral component of urban change.

Conclusion

This paper has demonstrated the way in which industrial archaeology contributes to the study of local history by utilising historic artefacts to complement documentary research into the evolution of industrial activity in the region. Since in Portsmouth the Dockyard has long been the principal engine of change, in many ways the industrial archaeology of the area reflects both shifts in government foreign policy and the progress of technology as it influences society as a whole. It is therefore not surprising that so many artefacts within the Dockyard and its ancillary establishments belong to quite specific time periods when the country was at war, or when there was a perceived threat of hostilities, while relics outside exhibit a more gradual evolution more related to change in urban society than to the exigencies of military thinking.

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[14] The maker was Ashworth Son and Co, Dewsbury

[15] Coad (1981), *op. cit.*, p. 36

[16] Compound columns are moulded to give the impression of a cluster of columns merging at their inner faces. A photograph may be found in Coad (1983), *op. cit.*, p. 90

[17] *Through the Royal Dockyard and Naval Establishments of Portsmouth, op. cit.*, p. 25

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[28] Steam powered rolling mills and tilt hammers were not introduced until the nineteenth century. The main function of the Gosport establishment was nail making, a manual operation.

[29] The plaque by the Historical Metallurgy Society was unveiled on 17 September 1983

[30] Horne (1965), *op. cit.*, p. 25

[31] Aisled barns have interior columns permitting greater breadth and thus larger storage space. For an interior photograph see David Lloyd, *op. cit.*, p. 28

[32] Anon, *History of the Dovecote*, (published privately by the owner of Manor Farm c. 1970), p. 2

[33] Glovers are open sided structures on the ridge or apertures in the gables allowing birds access

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[38] Ordnance Survey, 1:10560 Hampshire Sheet LXXVI (1869)

[39] Anon, 'Havant Water and Windmills', *The Making of Havant*, 1 (1977), pp. 8–9

[40] John Smeaton was the first to undertake a scientific study of waterwheels in 1752–3. He found that undershot wheels of the day were only 22 per cent efficient and recommended improvements such as canted sluices that more than doubled this rating. See Schools Council Project Technology, *Industrial Archaeology of Water Mills and Water Power* (Heinemann, 1975), pp. 5–6

[41] The stones are by Hughes & Sons of London, and the wheel by C. Sutton of Shirley

[42] F. H. Brownridge, 'Lumley Mill Emsworth', *J.P.C.T.I.A.S.*, 2 (1969), pp. 50–2

[43] M. D. Freeman, 'Armfield Turbines in Hampshire', *Industrial Archaeology*, 8 (1971), pp. 373–80

[44] The rebuild was occasioned by a fire in 1896 caused by the malfunction of an oil engine installed in 1894 to drive rollers

[45] The mill was converted to flats in 1985

[46] Steam mills were typically urban phenomena and as a result have usually disappeared. One such was the Landport Steam Flour Mills in Lake Road, Landport, but in spite of its mode of power it was smaller than the wind driven Dock Mill, Southsea. See Riley (1976), *op. cit.*, p. 18

[47] F. Brook, 'The Old Industries of Emsworth', *J.P.C.T.I.A.S.*, 1 (1968), pp. 18–21

[48] Old photographs show a chimney, indicative of steam power

[49] Owen Ward, 'French Burrstones. A Quest', *Association for Industrial Archaeology Bulletin*, 13, No. 3 (1986), p. 4

[50] David J. Rudkin, *The River Ems and Related Watercourses* (published privately, 1984), p. 80

[51] I am grateful to Mr A. C. Yoward for information on Emsworth tide mills

[52] James Bayes, 'They Mined Gold at Hayling', *Evening News* (30 May 1969)

[53] The Portsmouth and Sheet Bridge Commissioners decided to install milestones only in 1744. See J. Fernbank and W. H. Whiteman, 'Milestones on the Portsmouth Road', *Petersfield Area Historical Society Bulletin*, No. 6 (1977), pp. 9–11; also William Albert and P. D. A. Harvey (Eds), *Portsmouth and Sheet Turnpike Commissioners' Minute Book 1711–1754*, Portsmouth Record Series, Vol 2 (Portsmouth City Council, 1973)

[54] A list of coaching inns is cited by D. J. Viner, 'The Industrial Archaeology of Hampshire Roads', *Proceedings, Hampshire Field Club*, 26 (1969), pp. 155–72

[55] Drawings of the engine appear in Coad (1981), *op. cit.*, pp. 30–1

[56] For a drawing see Riley (1985), *op. cit.*, p. 9

[57] The caisson principle was proposed in 1703 by St. Lo, the Commissioner at Chatham, but this did not prevent Bentham from taking out a patent in 1812

[58] Sheers or sheer legs were the basic heavy lifting equipment until late nineteenth century, but their use persisted into the 1950s

[59] John Murray, *Her Majesty's Dockyard at Portsmouth* (March 1858), L(ocal) H(istory) C(ollection), P(ortsmouth) C(entral) L(ibrary)

[60] Coad (1983), *op. cit.*, p. 53

[61] *Through the Royal Dockyard and Naval Establishments of Portsmouth, op. cit.*, p. 20

[62] The Wood Mills comprised North, Middle and South Buildings. The principal block making machine shop was in the single storey Middle Building, whose queen post trussed roof is supported by classical columns in wood; it is likely that these were added later to allow lifting mechanism, line shafting, belt wheels and gearing to be positioned on the trussing

[63] A photograph of the vaulting appears in B. H. Patterson and R. C. Riley, *Portsmouth Royal Dockyard A Short Photographic History* P(ortsmouth) R(oyal) D(ockyard) H(istorical) S(ociety), (1984), p. 6

[64] K. R. Gilbert, *The Portsmouth Block Making Machinery* (Science Museum, 1965); Gregory Clark, 'Hampshire's Blockmaking Boffins', *Hampshire* (18 July 1978), pp. 39–40; Gregory Clark, 'Naval Blockmaking in the Eighteenth and Nineteenth Centuries', *The Mariner's Mirror*, 62 (1976), pp. 137–44

[65] Carolyn C. Cooper, 'The Production Line at Portsmouth Block Mill', *Industrial Archaeology Review*, 6 (1981), pp. 27–42; Riley (1985), *op. cit.*, p. 14

[66] Only ten men were required to carry out the work of 110 craftsmen. By 1808, 130,000 pulley blocks were being produced annually

[67] Dawn Jones, 'Marc Brunel in Portsmouth', *J.P.C.T.I.A.S.*, 1 (1968), p. 34

[68] *Through the Royal Dockyard and Naval Establishments of Portsmouth, op. cit.*, p. 20. This source mentions that water was raised into the tank by a steam engine

[69] Pevsner and Lloyd, *op. cit.*, p. 414

[70] H.M.S. *Rattler's* propeller is on show in No. 10 Storehouse

[71] The docks were permanently separated in 1924 by the construction of a fixed concrete wall

[72] B. H. Patterson and R. C. Riley, *Discovery of the Steam Basin Caisson* (P.R.D.H.S., 1984). Also a note in *Association for Industrial Archaeology Bulletin*, 11, No. 3 (1984), pp. 1–2

[73] Detailed plans of the building are given in Captain H. James, 'Description of the Steam Basin, Docks, and Factory, and other Works recently executed in Portsmouth Dockyard', *Geological Notice of the Foundation Papers of the Corps of Royal Engineers*, Series 2, No. 3 (1853), pp. 77–102

[74] Anon, 'Dockyard Excursion Notes', *Proceedings Institution of Mechanical Engineers*, No. 3 (1892), p. 373

[75] Derrick Beckett, *Stephensons' Britain* (David and Charles, 1984), pp. 123–4

[76] An inscription indicates that each girder is capable of carrying a load of 40 tons and subsidiary girders are lettered according to length for ease of assembly

[77] Anon, *H.M. Dockyard Portsmouth No. 3/4 Ship Shops* (Chalk Pits Museum, Amberley, 1979); Anon, 'Ship Shops Shattered', *Association for Industrial Archaeology Bulletin*, 7, No. 4 (1980), pp. 2–3

[78] J. H. Miller, (Plan of) *Royal Clarence Victualling Yard August 1858*, amended 1891, L.H.C., P.C.L.

[79] The dimensions of the ovens were: 13ft × 11ft × 1ft 5½in high. For a plan of the assembly see National Maritime Museum, ADM/Y/P/41

[80] Merritt, *op. cit.*, chapter 4 contains much useful information on Grant. Like Brunel's blockmaking machinery, Grant's machinery was described by many contemporary topographers. One such was Mackenzie Walcott, *A Guide to the Coasts of Hants and Dorset* (Edward Stanford, 1859), pp. 296–7

[81] Sir John Rennie, *The Theory, Formation and Construction of British and Foreign Harbours Illustrated by Numerous Examples* (John Weale, 1851–4), p. 74

[82] *Ibid.*

[83] The beer ration was abolished in the 1830s and the rum ration substituted

[84] J. H. Miller, *op. cit.*

[85] M. J. Freeman, 'The Carrier System of South Hanpshire', *The Journal of Transport History*, New Series 4, No. 2 (1977), pp. 61–85

[86] For details see P.A.L. Vine, *London's Lost Route to the Sea* (1965) and the *Hampshire Telegraph* (23 September 1822)

[87] There were six swing bridges: two in the Landport Basin, at Somers Road, Fratton Road, at what is now Priory Crescent, and Ironbridge Lane

[88] Gordon Biddle, *Victorian Stations* (David and Charles, 1973), p. 63

[89] Further details appear in G. A. Allcock, *Gosport's Railway Era* (Gosport Historic Records and Museum Society, 1975), p. 18

[90] The term 'upside down station' springs from this arrangement

[91] Fencing on the south side has posts of bull head rail inscribed 'Cumberland Steel 1878' and '1881', similar posts on the north side are dated 1884, and the pedestrian bridge is by Joseph Westwood & Co., London, 1890. Photographs and other details appear in R. Brown and W. Greer, *Fairdays and Tramdays The Story of Cosham* (Milestone Publications, 1983)

[92] For a photograph of the contraption, see Vic Mitchell and Keith Smith, *South Coast Railways Portsmouth to Southampton* (Middleton Press, 1986), plate 25

[93] G. Measom, *The Official South Western Railway Guide* (no date), p. 447

[94] Sir Sam Fay. *A Royal Road* (1883), cited by Gordon Biddle, *op. cit.*, p. 126

[95] Ordnance Survey 1:500 Hampshire Sheet LXXXIII, 8.21, surveyed 1861 and published with amendments 1867 shows the alignment of both the old and the new stations

[96] Dugald Drummond was Locomotive Superintendent of the London and South Western Railway from 1895 to 1912

[97] 'Loping' is the term employed by Ian Nairn to describe the edging given to valances by the London Brighton and South Coast Railway

[98] Ellis, *op. cit.*, p. 11

[99] Roger Hateley (Ed), *Industrial Locomotives of Central Southern England* (Industrial Railway Society, 1981), J74

[100] The rail and tramway networks are clearly shown in the map by John Murray, *op. cit.* See also Riley (1985) *op. cit.*, pp. 21–2

[101] The Portsmouth Dockyard Act. Details are cited by Colonel Andrew Clarke, 'The Dockyard Extension Works at Portsmouth', *Engineering* (9 September 1870), pp. 181–2

[102] Charles Colson, 'Portsmouth Dockyard Extension Works', *Proceedings Institution Civil Engineers*, 64 (1880–1), p. 119

[103] The Fitting Out and Rigging Basins were 14 acres, and the Repairing Basin 22 acres in extent

[104] Photographs of the operating mechanism appear in Riley (1986), *op. cit.*, p. 184

[105] Comprehensive details of the engineering works involved are given by Christian Hendrick Mayer, 'Temporary Works and Plant at the Portsmouth Dockyard Extension', *Proceedings Institution of Civil Engineers*, 64 (1880–1), pp. 174–206. An excellent photographic record of the work is to be found in *Portsmouth Dockyard Extension. Photographs of the Work in Progress of Execution*, L.H.C., P.C.L.

[106] For details see Riley (1985), *op. cit.*, pp. 23–6

[107] Photographs appear in B. H. Patterson and R. C. Riley, *Portsmouth Royal Dockyard A Short Photographic History* (P.R.D.H.S., 1984), pp. 23–5

[108] The building appears on a map in John T. Corner, 'Description of the Lifting and Hauling Appliances in Portsmouth Dockyard', *Proceedings Institution of Mechanical Engineers* (July 1892)

[109] In the 1860s hydraulic power was introduced into the Georgian dockyard to work capstans and lifts. The engine house is adjacent to the Camber, but unused

[110] David W. Lloyd (1974) *op. cit.*, pp. 59–60; Riley (1985), *op. cit.*, p. 25

[111] At the same time a line was built from the Harbour station into the Gunwharf

[112] R. Edmund Froude, 'Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experimental Works, Haslar', *Proceedings Institution of Mechanical Engineers*, 44 (1893), pp. 32–40; Lesley Burton, 'Haslar's Historic Ship Tank', *Gosport Records*, 3 (1972), pp. 18–24

[113] Mackenzie Walcott, *op. cit.*, p. 296

[114] I am grateful to Mr J. D. Merriman for information on the operation of the Elephant

[115] It has not proved possible to ascertain the condition of the transverse slipway

[116] An interior photograph appears in John Leyland, 'Victualling the Navy, Royal Clarence Yard Gosport', *The Navy and Army Illustrated* (21 September 1901), p. 24

[117] Basil Ripley, *Horsea Island and the Royal Navy*, The Portsmouth Papers, No. 36 (1982) p. 7

[118] *A Short History of Whale Island* (Charpentier, Portsmouth, 1919), p. 30. Photographs of the railway appear in *Portsmouth Dockyard Extension Photographs of the Work in Progress of Execution*, plates 9–11 taken 17 June 1868

[119] Photographs kept on Whale Island indicate that the crane had a fixed wooden jib with steam generated in a coffee pot boiler

[120] Riley (1976), *op. cit.*, p. 10

[121] R. C. Riley, 'Military and Naval Land Use as a Determinant of Urban Development. The Case of Portsmouth', in M. Bateman and R. C. Riley (Eds), *The Geography of Defence* (Croom Helm, 1987), pp. 52–81; for a general analysis see R. C. Riley and J-L. Smith, 'Industrialisation in Naval Ports: the Portsmouth Case', in B. S. Hoyle and D. A. Pinder (Eds) *Cityport Industrialisation and Regional Development* (Pergamon, 1981), pp. 133–50

[122] The manufacturer was Henry Grissell of the Regent's Canal Ironworks

[123] R. C. Riley, 'The Portsmouth Corset Industry in the Nineteenth Century', in John Webb, Nigel Yates and Sarah Peacock (Eds), *Hampshire Studies* (Portsmouth City Records Office, 1981), pp. 241–64

[124] R. C. Riley, 'Rate Returns and Industrial Geography. Nineteenth Century Brewing in Portsmouth', in D. N. Mottershead and R. C. Riley (Eds), *Portsmouth Geographical Essays*, 2 (1976), pp. 66–75

[125] Photographs appear in Moore, *op. cit.*, p. 15 and drawings may be seen in a leaflet *Southwick Brewhouse*, Southwick Estates (no date). Restoration was carried out by Southampton University Industrial Archaeology Group in conjunction with Hampshire Buildings Preservation Trust and Southwick Estates. For other brewery remains see M. F. Tighe, 'A Gazetteer of Hampshire Breweries', *Proceedings Hampshire Field Club*, 27 (1970), pp. 87–114

[126] W. C. F. White, 'A Gazetteer of Brick and Tile Works in Hampshire', *Proceedings Hampshire Field Club*, 28 (1971), p. 90

[127] The manufacturer was Joseph Hamble of West Bromwich

[128] For details of the original Easton and Anderson engines, see Frederick Colyer, *Pumps and Pumping Machinery* (1887), pp. 24–5

[129] Cogswell was particularly active in the design of public houses, see R. C. Riley and Philip Eley, *Public Houses and Beer Houses in Nineteenth Century Portsmouth*, The Portsmouth Papers No. 38 (1983)

[130] Gosport was supplied from Soberton from 1907

[131] The major source on water supply is D. Halton Thomson, *A History of the Portsmouth and Gosport Water Supply* (Portsmouth and Gosport Water Co., 1957). See also Mary Hallett, *Portsmouth's Water Supply 1800–1860*, The Portsmouth Papers No. 12 (1871)

[132] Anon, 'Gas Supply in Havant', *The Making of Havant*, 3 (1979), pp. 60–1

[133] R. C. Riley, 'The Retort Houses of Hilsea Gasworks Portsmouth', *J.P.C.T.I.A.S.*, 2 (1969), pp. 3–11

[134] For further details of the gas industry see Moore, *op. cit.*, pp. 40–1

[135] One of the beam engines is regularly steamed by Portsmouth City Museums

[136] This equipment was rescued by volunteers and is now on show at Eastney pumping station

[137] The gashouse, now the property of Portsmouth City Museums, also contains a number of gas and oil engines put into working order by a group from Portsmouth Polytechnic, 1972–8

[138] E. A. Course, *Eastney Pumping Station* (Portsmouth City Museums, 1975)

139 W. E. C. Chamberlain, *A History of Portsmouth Drainage 1865–1956* (Portsmouth City Council, 1956)

140 T. N. Butters, 'The East Southsea Railway', *J.P.C.T.I.A.S.*, 1 (1968), pp. 25–30

141 For photographs see Mitchell and Smith, *op. cit.*, plates 79–85; also Kevin Robertson, *The Southsea Railway* (Kingfisher Railway Productions, Southampton, 1985)

142 In the Edwardian period the LSWR and LBSCR companies constructed two blocks of flats together with two substantial semi-circular wash houses for their employees to the north of the station. Until its recent demolition the entrance to the site had stones inscribed with the names of the two companies. The flats have recently been refurbished

143 For photographs of the *Carrier*, plans of the ramp and an extract from *Engineering* for 7 August 1885, see Vic Mitchell and Keith Smith, *Branch Line to Hayling* (Middleton Press, 1984), plates 57–9

144 Edwin Course, *Portsmouth Railways*, The Portsmouth Papers No. 6 (1969) provides a history of the region's network

145 Photographs appear in Moore, *op. cit.*, p. 49

146 S. E. Harrison, *The Tramways of Portsmouth* (The Light Railway Transport League, 1963); M. J. White, 'The Portsdown and Horndean Light Railway', *J.P.C.T.I.A.S.*, 2 (1969), pp. 87–93; Edwin Course, *Portsmouth Corporation Tramways 1896–1936*, The Portsmouth Papers, No. 45 (1986)

147 D. A. P. Janes and R. G. Funnell, *The Trolleybuses of Portsmouth* (The Reading Transport Society, 1969)

148 'Penfold' boxes were in production between 1859 and 1879

Portsmouth Record Series

Borough Sessions Papers 1653–1688 by Arthur J. Willis and Margaret J. Hoad. MA, 1971 (Illus.).

Portsmouth and Sheet Turnpike Commissioners' Minute Book 1711–1754 edited by W. Albert and P. D. A. Harvey, 1974 (Illus.).

Book of Original Entries 1731–1751 edited by N. W. Surry and J. H. Thomas, 1976 (Illus.).

Maps of Portsmouth before 1801 compiled by D. Hodson, 1978 (Illus.).

Other publications available

Fortifications in Old Portsmouth by A. Corney, 1965 (Illus.).

Southsea Castle by A. Corney, 1967 (Illus.).

The Civic Plate and Insignia of the City of Portsmouth (reprinted from the Connoisseur) by Sir C. Oman, 1965.

Guide to Historic Portsmouth (in colour).

Records of the City of Portsmouth 1835–1935 (Bound and Illus.) in three volumes, *1936–55* (Bound and Illus.) in two volumes.

Buildings of Portsmouth and its Environs by D. Lloyd, 1974 (Bound and well illustrated).

Hampshire Studies edited by John Webb, Nigel Yates and Sarah Peacock, 1981 (Illus.)

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47. *Sir Frederic Madden and Portsmouth*, by John Webb, MA, FRHistS, 1987 (Illus.).
48. *The Industrial Archaeology of the Portsmouth Region* by R. C. Riley, BSc(Econ), PhD 1987 (Illus.).

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